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The Springfield Plan

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"I have heard of the Springfield plan. Please send me your course of study." Again and again this request has come to us from the teacher seeking help, from the teacher in search of statistics, and from the critic. Each of these is disappointed and apparently shocked when we try to point out that we lay no claim to having solved all of the problems of general science, and that our "course of study" is not a panacea for all the ills to which that subject is heir.

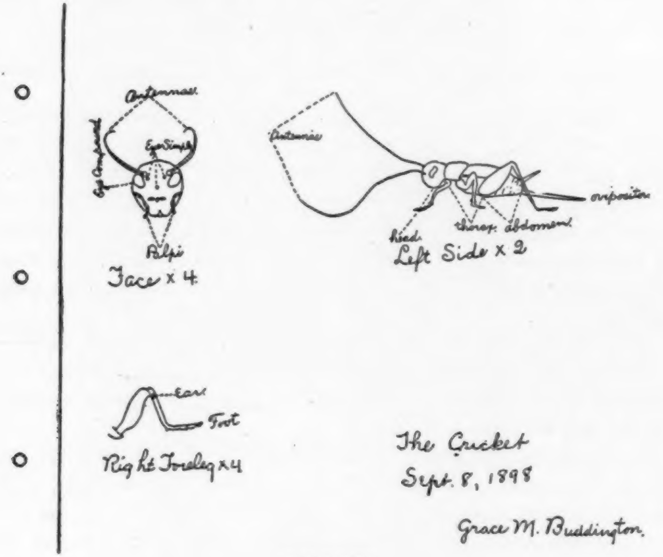
The "Springfield Plan" is not a course of study. It is a method of instruction which has served *our* needs well. This method is not peculiar to general science. It may be applied with equal facility to any and all science courses.

The "Springfield Plan" is not exactly a plan, either. It is, rather, the result of the growth of an idea; the result of study, trial and experiment. In attaining this result, the teacher has been absolutely unhampered. There has been no final examination to be met, no college requirement to consider. The only aim has been to minister to the needs of the pupil in the best possible manner.

This article is a brief story of that growth. It tells of a changing point of view, and a gradual approach to a more nearly satisfactory solution of the problem of elementary science.

When the new Central High School building was opened in September, 1898, great emphasis was being laid on the study and teaching of biology, particularly as a first year subject. This is well shown by the allotment of rooms in the science department. Of the eight rooms given over to science, four were biological laboratories, one a chemical laboratory, one a geological laboratory, and

two were physical laboratories. Exactly one-half of the science space was to be devoted to biological instruction. The course designed for the Freshmen, and required of them, was one in biology, so-called, and consisted of a half year of zoology and a half year of botany. The work was done mainly in the laboratory, and the nature and content of the course is well shown by the following outline and specimen page from the note book of a pupil who entered the school that year.



BIOLOGY.

Central High School, Springfield, Mass.

1898—1899

THE CRICKET. Drawing—1 page. (See cut.) Description. Sense organs. Metamorphosis: direct; indirect.

THE SPIDER. Drawing—1 page.

THE EARTHWORM. Drawing—1 page. Description.

PROTOZOA. Drawing—1 page. Protoplasm. Root animalcules. Gregarines. Infusoria. Amoeba: 1. Habitat. 2. Structure. 3. Feeding. 4. Excretion. 5. Respiration. 6. Locomotion. 7. Irritability. 8. Reproduction. 9. Resting stage.

PORIFERA. Drawing—1 page. Description. Classification.

THE HYDROID. Drawing—1 page. Description.

THE SEA ANEMONE. Drawing—1 page. Description.

HYDRA. Description.
THE STAR FISH. Drawing—3 pages. Description.
THE TULIP. Drawing—2 pages.
HORSE CHESTNUT. Drawing—2 pages.
CHERRY TWIG. Drawing—1 page.
SQUASH. Drawing of seed and plant—1 page.
CORN. Drawing of seed and plant—1 page.
THE PEA. Drawing of seed and plant—1 page.
THE VIOLET. Drawing—1 page.
STARCH. Drawing of starch grains—1 page.

EPERIMENTS:

1. Does light assist germination? Does light retard germination?
2. Will seeds germinate without air?
3. Are the cotyledons of a seed of any use to the seedling?
4. Does the amount of material in a seed have anything to do with its germination?
5. Of how much use to the corn seedling is the endosperm?
6. Do seeds contain starch?
7. How can the presence of grape sugar be detected?
8. What change does the starch in seeds undergo during germination?
9. Do seeds contain oil?
10. Do seeds contain proteids?
11. How is the growth of the pea carried on after the destruction of the plumule?
12. Do two liquids in contact with one another mingle?
13. Can two liquids separated from one another by a moist membrane mingle?
14. If the two liquids in Experiment 13 are of unequal density, is the greater flow from the denser to the less dense or vice versa?

THE RADISH. Drawing—1 page.
ROOT OF DAHLIA. Drawing—1 page.
UNDERGROUND STEMS. Drawing—1 page.

This course was intended to introduce the pupil to the world of science and to arouse his interest in science work, but in meeting the latter part of this aim it was not an unqualified success. It was worked out according to the best pedagogical practice, but instead of interest, a marked distaste, almost amounting to disgust, appeared. "How we hated that old bugology! I can smell the pickle yet," said one of the pupils to me recently. Work of this sort, particularly the zoology, is by its very nature calculated to arouse either intense enthusiasm or profound dislike—the enthusiasm being limited, usually, to a very few. As a matter of fact, no one science will ever arouse and hold the interest of a class composed of a large number of individual boys and girls whose tastes

run to all sorts of extremes. In this case biology failed because, as taught, it was a subject too deep for the age of the pupil, requiring skill in dissection, clearness in reasoning, and the ability to differentiate.

The course continued, however, in substantially the same form for six years, becoming more and more unsatisfactory all the while. Occasionally a teacher of more than ordinary ability could make the work endurable, but on the whole, it failed to prove its right to an existence. It was found, also, that the unsatisfactory introduction to the science work was reacting unfavorably on the whole science department. The size of classes in the elective sciences was decreasing, because to the pupil "science" was synonymous with the course in biology. It was evident that some radical change must be made if the science was to hold the place it deserved in the work of the school. To none was the need for a change more evident than to Dr. Thomas M. Balliet, then Superintendent of Schools, and Mr. William Orr, then Principal of Central High School, and Springfield owes whatever of credit she has received for originating a plan of first year science work to the courage and foresight of these two men—a fact which they are far too modest to admit.

It was determined to break sharply with the old course and to start afresh along new lines and with somewhat different aims. The purpose of the new course was two-fold:

1. To give the pupil a broad and helpful view of the whole field of science, especially as it touched his daily life.

2. To lay special emphasis upon the fact that the science of the school and the science of the "outside world" are identical.

In scope, the course has gone far beyond even the dreams of the far-seeing men who planned its beginning, but it has adhered steadfastly to their ideals, and with uniform success.

In September, 1904, Mr. Waterman S. C. Russell was secured to be the first teacher of the course, and to him is due the credit of instituting a practical plan of work. On account of conditions within the science department, the course for the first year consisted mainly of mild physics, with numerous practical illustrations, together with some chemical notions, but the relief from the strain of the biology course was evident immediately, and there was every inducement to continue. The next year something of astronomy crept in, and the course became more definitely and distinctly re-

lated to the home. Little by little the other sciences found their place, until the course became in fact, as well as name, a course in *general* science.

Almost from its inception the epithet "hash" was thrown at the work by those who failed to appreciate its purpose, or who were definitely committed to some one subject, such as biology or physiography, as an introduction to science. To some extent this criticism was justified. The various problems—the term "project" was not in use at that time—were not closely related, and there was a lack of cumulative effect, which made it difficult to group the knowledge and experience gained under general heads.

This need of closer and more systematic organization was felt quite as acutely by the friends of the course as by its critics, and various plans for overcoming the difficulty were tried. The final solution was the organization of the material into a number of large general units, each having a definite relation to the life of the city, and, therefore, a definite interest to the pupil. Problems thus presented seemed to him worthy of solution. He could, and did, bring to bear his previous experience, and he could appreciate, to a much greater degree, the general underlying principles.

It was found, also, that this method brought together the whole family of sciences in harmonious relations. For example, one unit studied—the classic one—is "Springfield's Water Supply." When this is studied from its source in the springs and brooks to its use in the homes of the pupils, it is necessary that reference be made to almost every branch of science, though the specific names of these branches may never be mentioned. Physics and chemistry, biology, physiography, bacteriology, forestry and sanitation—a knowledge of each is essential to the construction and proper operation of a modern water system. In a similar way other common activities may be grouped into general units, and taught more effectively and forcefully than as isolated topics, each comparatively meager in content. As a practical working plan, this system needs no defense. Its success is its own justification.

With the formal inauguration of the junior high school in February, 1917, a new situation was produced. Previously each of the three high schools had determined its own course. Now it became necessary to formulate one uniform course which should be acceptable to each of the senior high schools, and which should not be a hindrance to any pupil in future science work. Somewhat to the surprise of all, the heads of the science departments in the

three high schools were found to be in complete accord, and with principals of grammar schools and the supervisor of nature study in agreement, the following course was suggested and adopted:

GENERAL SCIENCE.

JUNIOR 3.

Outline of the Course

PURPOSE.—The chief purpose of this course is to offer an opportunity whereby the pupil may broaden and deepen his interest in natural phenomena. His study of the subject should promote a wide outlook, and should minister to his intellectual life by the gratification of mental desires in an increasing appreciation of the delight and satisfaction to be found in the study of nature.

The primary aim of general science is to give large opportunities for the exercise, along the line of the pupil's interests, of his inherent desire to know more of his physical environment, rather than to require the mastery of a certain body of organized knowledge or a command of formulae, or to develop expert scientists, or to train explicitly in scientific method.

Instruction in general science should lead to a more extended reading of articles on science, in magazines and newspapers, and of scientific books of both popular and technical character. There should be a readier understanding of scientific allusions, increasingly found in general literature.

The pupil should learn, also, how to use certain instruments and appliances, as balances, rulers, and graph paper. Practice should be given in the systematic arrangement of data in tabular form and graphic presentation. The pupils should gain in skill and power to use reference books, such as dictionary, encyclopedia and readable texts. Information on scientific matters should thus be made easily accessible.

ORGANIZATION OF THE COURSE.— In organizing the course, the following factors should be kept constantly in mind.

1. The course is to be planned with particular reference to Springfield, its location, its interests and its needs.
2. It is to be a course in *general* as opposed to *particular* or specific science.
3. It will be a half-year course, that is, five (5) periods of work a week for twenty (20) weeks.
4. It is to include a considerable amount of laboratory work done by the pupil, either in school or at home.
5. It should consider carefully and, in every way possible, build upon the work previously done in the grades. Incidentally, it should include a continual review of former science work.

ORGANIZATION OF MATERIAL.— General science material should be organized as a number of general units. Each unit should consist of a large central theme involving problems of various kinds so re-

lated to the experience and interests of the pupil as to make him feel that their solution is worth while. These problems should of themselves make it clear that the science of the school and the science of the "outside world" are identical.

When these units are wisely selected and well organized, the pupil should find something in each to arouse genuine enthusiasm and to challenge to vigorous effort. While at times the several problems in a unit may seem to be unrelated, when the results are summarized the relation of each to the main unit should be clearly seen.

While each project or problem in a given unit should be complete in itself, cumulative effect is produced by grouping together a number of projects belonging in the same field. Without such relationship a succession of isolated and comparatively limited projects and undertakings will result, and there will be failure to group the knowledge and experience gained under general heads.

OUTLINE.— The following general units are selected for this course. As it will be found impossible to complete, even approximately, all of them in the space of the half-year allotted, certain portions have been starred (*) as required. The remaining portions may be considered, as time permits, at the discretion of the teacher and according to the bent of the class.

1. Foods.
2. The Houses We Live In.
3. Keeping Well.
4. Cleansing and Dyeing.
5. Household Electrical Appliances.
6. The Weather.
7. Our Neighbors In Space.
8. What Time Is It?
9. Springfield's Water Supply.

These units may include, along with reading, study and original investigation by the pupil, the following lectures, or talks *with the class*, and exercises, laboratory or home, which bear upon the same subjects.

FOODS

CLASS TALKS	EXERCISES
*Food and Its Adulteration.	*Coal Tar Dyes.
*Color in Foods.	Other Dye Tests.
Coffee and Its Relation to Health.	*Coffee Tests.
*Milk and Butter.	*Butter Tests.
*Eggs.	*Babcock Milk Test.
Food Preservatives.	Preservatives in Milk.
*Flavoring Extracts.	Pasturized Milk.
Science and the Food Supply.	Ice Cream.
Food and Health.	*Study of Eggs.
	*Making Flavoring Extracts.
	Preparation and Test of Starch.
	Starch and Sugar in Foods.

THE HOUSES WE LIVE IN

The Forest and Its Products.
Clay and Bricks.
Cement and Concrete.
Wood Through a Microscope.
*Ventilation of the House.
*Heat in the Home.
*Fires and Fire Extinguishers.
*Home Lighting.
Science and Decoration.
*Carbon Dioxide In Air.
*Testing the Ventilation of a Room.
*Cost of Some Fuels.
*The Hot Water Tank.
*Our Home Heater.
Our Refrigerator.
Ice Cream Freezers.
*The Fireless Cooker.
Testing Lights.

KEEPING WELL

The Sanitary Home.
Personal Hygiene.
*Tooth Preparations.
*Headache Preparations.
*Patent Medicines.
*Habit Forming Drugs.
*Preventable Diseases.
*Test of Tooth Preparations.
Making Tooth Powders & Pastes.
Test of Headache Preparations.
*Toilet Preparations.
*Moulds.
*Growing Bacteria.

Note:—Constant reference will be made to matters of health and hygiene in connection with other work of the course.

CLEANSING AND DYEING

*Physical and Chemical Changes.
*Soap and Its Uses.
Removal of Stains.
Bleaching.
*A Trip Through a Laundry.
Dyeing at Home.
Where Do We Get Our Dyes?
*Litmus Tests.
*Making Soap.
*Tests of Ink Eradicators.
Javelle Water.
*Removing Common Stains.
Tests of Washing Powders.
Tests of Cleansing Fluids.
*Dyeing Tests.
Inks.

HOUSEHOLD ELECTRICAL APPLIANCES

*The Story of Electricity.
*Heat and Light From Electricity.
Other Electrical Effects.
*How Electricity Is Produced and Measured.
*Electricity In The Home.
The Electric Bell.
Bell Wiring Problems.
*Tests of Household Electrical Devices.
*Lamp Tests.

THE WEATHER

*Our Atmosphere.
*Air In Motion.
*Clouds, Fog, Mist, Rain, Dew and Snow.
Work of the United States Weather Bureau.
Effects Produced by Weather.
Water Power in New England.
Testing Air for Oxygen and Nitrogen.
*Temperature Graphs.
Dew Point and Humidity.
*Weather Record.
Making a Weather Map.
*Almanac Weather Predictions.
*Rainfall and Forests.
Water Power Map of New England.

Note:—The study of the weather, particularly the keeping of records and notes on special conditions, should be continued throughout the semester.

OUR NEIGHBORS IN SPACE

*Astronomy of Everyday Life.
*The Moon, Our Nearest Neighbor.
*The Sun, Our Distant Neighbor.
*The Planet Mars, Our Sister World.
*Comets and Meteors.
*The Stars, Our Very Distant Neighbors.
*Finding a Meredian.
*Monthly Record of the Moon.
*Sunrise and Sunset Graphs.
*Heat From the Sun at Different Angles.
*Constellations.
Latitude by Altitude of Polaris, or by Gnomon.

WHAT TIME IS IT?

*Local and Standard Time.
*How Time Is Kept.
Ancient.
Modern.
*The Calendar.
*Map of Time Belts.
*Rotation of the Earth and Its Effects.
Longitude of Springfield.
Time Signals.

SPRINGFIELD'S WATER SUPPLY

*Growth of Our Water System.
*Reservoirs and Their Location.
*Purification of Water.
Conserving the Supply.
*Water Pressure.
*Water Tests.
*Charcoal as a Filter.
*Household Filters.
Hard and Soft Water.

TEXT BOOKS.—Text books should be used mainly for reference purposes, and not as an outline of a course. It is desirable, therefore to have at hand a number of different texts, and those already in use in the several high schools should be turned over to the Junior High School as soon as practicable.

Leaflets, each dealing with some particular project, and prepared especially for local use, make the best text book in the commonly accepted meaning of that term. They should be prepared largely by those in charge of the work and printed, if possible, by the Practical Arts classes in the various schools. The use of such leaflets relieves the pupil of the somewhat arduous task of writing up reports of lectures, and serves the purpose equally well.

LABORATORY MANUALS.— The laboratory manual, like the textbook, should be made to fit our own particular needs. The various exercises should be printed. The teacher can give directions, when these are needed, more easily and clearly, and as the time sometimes wasted in dictation is saved, more real work can be done in a given number of lessons. The pupil escapes the purely mechanical work of recording results, a task which too frequently causes him to miss the real point of the exercise which he has performed. This in no way lessens the training in orderly arrangement of material, and will often prevent the pupil from becoming discouraged. The production of an elaborate system of notes is not one of the purposes of the course. The note book should be considered a means rather than an end.

The foregoing represents the last stage, to date, of the "Springfield Plan." We do not accept it as final. It is not even our ideal. We are looking for improvement, but it seems to be, *for us,* the best solution of our present problem, and that, after all, is about the only qualification that we can absolutely demand of a course in general science.

History of the General Science Movement[1]

GEORGE D. VON HOFE, JR., Teachers College, Columbia University.

The story of the General Science Movement traces itself through many years, but not until recently has it become significant in aiding the science teacher to meet the demand for an improvement in science instruction. The history of the teaching of general science is still to be made. It had a beginning that was curtailed fifty years ago, and the revival is just appearing. Since the break, as far as the writer is aware real general science, the kind that is discussed by Professor Woodhull in his "Science Teaching by Projects"[2], has not been prominent in any school. All we can trace is the history of the opposition to, and the breaking away from methods which are a check on the pupil's natural progress.

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[1] Abstract of an address delivered at Teachers College Science Round Table.
[2] School Science and Mathematics, March, 1915.

The academies in the seventeenth and eighteenth centuries repsented in more ways than one a revolt against tradition. In Isaac Watts' "Free Philosophy" we read:

> "I hate these shackles of the mind
> Forg'd by the haughty wise;
> Souls were not born to be confin'd
> And led like Samson blind and bound,
> But when his native strength he found
> He well aveng'd his eyes."

This was in the seventeenth century. Ferguson, of the next century, can be considered one of the earlier advocates of general science, though that term was then unknown. There is nothing to prevent our going back still further to earlier scientists, but to keep within rational limits let us begin here. In speaking of Ferguson's book Professor Mann says: "An inspection of the contents of this book shows us why the knowledge it contained was useful. Sixty-two pages are devoted to mechanics, and forty pages to pumps . . . An age of machinery and invention, an era of rapid industrial expansion, was developing, and the classics were unable to meet the demand for information on these subjects . . . A new type of information was needed and demanded by the public; and natural philosophy and the other sciences were invoked to meet the need and supply the demand."[3]

Pioneers of science, such as Faraday, Arnott, Davy and Ferguson, famous for their ability in the field of science, were at the same time genuine teachers of science. In their lectures they taught an almost ignorant public facts that today would be considered difficult. This they accomplished by popularizing their subject matter.

In 1869, George B. Emerson in his treatise on "Education in Massachusetts" shows what the reactionaries of that day stood for. Speaking of the children of a century or two earlier he says: "In winter they helped to clear the woods and cut down the forest trees, sledded the logs to the wood-pile and the timber to the mills, and assisted at first in hewing it, afterward, in sawing it into beams, posts, joists, planks, boards, clapboards, and shingles, or squaring it and building it directly into houses. . . . Has any system been

[3] C. R. Mann, Teaching of Physics, pp. 32-3.

devised to take the place of this and give the young man, in a higher degree, full possession of all his powers and faculties of body and mind, or to give him, in the same degree, the masculine qualities of hardy self-reliance with cautiousness, manly courage with coolness, resolution with patience, and power of endurance with habits of strenuous and cheerful labor? . . .

"Everybody is now ready to admit the important place which natural and physical science should have in a liberal education; but all are not aware that such science, to be real, must be founded on personal observation. These boys were laying such a foundation. A boy engaged in stoning a well, in raising stones for a wall, or in drawing water from the well by an old fashioned well-pole, was studying the properties of the lever. In splitting logs, he became acquainted with the wedge; in making roads, with the inclined plane. In helping to lay out a farm, with a surveyor's chain and compass, so as to fix, justly and accurately, the bounds between neighbor and neighbor, he got the first elementary ideas which lie at the very foundation of geometry . . . Even in his play he was still at his studies. In rowing, he was studying the lever; in sculling, the resolution of forces,—feeling as well as seeing . . . When for the well-pole he substituted the windlass, and with it drew water from the well, he was learning the nature, by observing the uses of the wheel and axle . . . Such was the necessary but real and noble preparation for college which was given to nearly all the boys in Massachusetts purposing to receive the highest education of the time. Has anything better been yet introduced to take the place of such a preparation? Does the vast time given to arithmetic, destined to be never used; or the innumerable lessons in geography, destined to be speedily forgotten; or the volumes of choice and exquisite selections from the best and finest poetry and prose, most of it wholly beyond the capacity of those who are to read them,—give a better preparation?"[4]

And later he says: "What a pleasant way of learning a language must that have been! —Walking about with the teacher over the farm, in the barn-yard, and in the woods; and learning from him how to speak, in Latin, of all they saw . . . how deeply fixed in the memory must all the usual forms of the language thus become!"[5]

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[4] George B. Emerson, Education in Massachusetts, pp. 9-11.

[5] George B. Emerson, Education in Massachusetts, p. 11.

It is not hard for us to see why these early colonists of New England should have given education of so high a standard. The leaders of the first emigration to Massachusetts were the most highly educated men that ever led colonies, and were symbols of independence and love of liberty. "They possessed and long continued to exert, an influence of the highest and noblest kind . . . we may search the world in vain for more conspicuous, unselfish devotion to the cause of what they believed to be truth and the rights of humanity."

I need but mention the advance made by such books as Rolfe and Gillet's (1870), Steele's Fourteen Weeks Series which were in one quarter of the schools, Gage's Elements of Physics (1822), which bore on the cover the words "Read Nature in the Language of Experiment", Avery's (1884), and Paul Bert's First Steps in Scientific Knowledge, the introduction of which caused a stir in the schools. These books are rightly called books of the informational type, but should not be condemned for that.

When natural science was first introduced into the course of studies, algebra and geometry were emphasized. Astronomy followed closely behind, and it in turn brought along natural philosophy, which often absorbed astronomy. Chancellor Brown, referring to this period, writes: "Geography . . . began to be emphasized. . . .There were many interesting things in the text-book, and the subject was intrinsically attractive, besides offering a great store of information."

After the middle of the nineteenth century there was a demand for informational courses. Brown goes on to say that the result "was that 'multiplicity of short informational courses', particularly in the natural sciences, against which the Committee of Ten protested. A group of text-books bearing the titles "Fourteen Weeks in Chemistry and Fourteen Weeks in each of the several other subjects, obtained a wide popularity at this time, and was highly characteristic of the tendency referred to."[6] It would appear that this Committee of Ten formalized and limited those studies which still had some small breadth of freedom.

Henry Kiddle, City Superintendent of New York Schools from 1870 to 1879, fostered the teaching of science. In 1870 he had astronomy taught during the last two years of the grammar school, and had a special teacher give two or three lessons a week in Fa-

[6] E. E. Brown, Making of Our Middle Schools, p. 417.

miliar Science. In 1871, the first two and a half years of the grammar grades gave elementary science—the qualities and uses of familiar objects, clothing, food, materials for building, zoology, botany, mineralogy and hygiene. In the last year and a half natural philosophy and facts in chemistry were offered. From these early attempts it can be seen that Kiddle was trying to give the child a broad survey and at the same time a definite understanding of things vital to him. From his attitude it would appear that he was a forerunner of the movement now on foot. However, when a subject is first introduced into school, it retains much of the outside life characteristic. This may be one of the factors for making the science of Kiddle's day so vital in subject matter. As a subject continues in the school and is twisted to yield to the likings and conveniences of the teacher, its tendency is to become formal. Mr. Harrison, Assistant Superintendent, speaking of natural philosophy in 1872, said: "This subject has evidently awakened a wide and profitable interest in classes and teachers; and considerable progress of a satisfactory character is already manifest . . . A number of teachers still manifest a strong tendency to begin with and dwell upon a series of definitions, instead of teaching the subject objectively. I am encouraged to hope that further experience will lead to the abandonment of a method so ill adapted. . ."

In 1884 the United States Bureau of Education issued a bulletin advocating inductive teaching, simple experiments in familiar units, and training in the scientific method of thinking. Professor Mann says: "These ideas found frequent expression at this time (1884); yet in spite of this, they were not followed in the subsequent development of physics teaching. Now there is a general demand for a reorganization of this teaching in conformity with the ideas that were so prominent twenty-five years ago."[7]

At about the same time, from 1881 on, there was in Boston a superintendent who strenuously opposed formula studies. Seaver believed that the first step in good teaching was an appeal to the observing powers, and that words and other symbols should not be allowed to intervene, tempting the learner to satisfy his mind with ideas obtained at second-hand. He said: "Faraday never used the term gravitation in elementary lectures without at the same time recalling to the minds of his hearers, by letting a stone fall to the floor, or otherwise, a vivid idea of the thing signified by that word."

[7] C. R. Mann, Teaching of Physics, p. 53.

In the report of 1881 he writes: "How many of our text-books begin, not with the suggestion of concrete illustrations, but with abstract definitions, and still more abstract 'first principles'—blind guides to the blind teacher, and sources of perplexity to teachers who are not blind." He advocated cutting the schools loose from one another and freeing them from the necessity of sacrificing the interests of their pupils for the sake of uniformity.

About fifteen years ago, when New York City was consolidated and Maxwell superintendent, there were a great many changes in the course of study. The idea of having special teachers for a particular subject became popular in New York and suburbs as well as in other cities. But teachers assigned to science for instance, knew very little about it. A large number of them sought information at Teachers College. Saturday mornings they gathered here and filled the largest lecture room in the building. At that time the manufacturers of syllabi were even more famous than they are today. The special teacher was given a syllabus which gave every experiment and bit of information in detail.

At about the same time E. H. Hall was doing a similar work at Harvard for teachers of Cambridge and its suburbs. The high school teacher complained that the student who came to him had not the first inkling of science. This brought forth the notion of *preparing* the child for high school science, just as we prepare the high school youth for college science. To carry out this operation Professor Hall took from the high school physics (Hall and Bergen, A Text Book of Physics) the first 178 pages, which apparently were "fundamental", and published them in a book about one-third as large as the high school text, calling it Lessons in Physics. It might have been an advantage to the beginner in science had he been given the benefit of the more interesting padding which the larger edition contains.

The tendency in the direction of general science is seen further in the movement started at Springfield in 1904. Dr. Balliet, then superintendent of schools in Springfield, and Mr. Orr, Principal of the Central High School felt that physics was altogether too quantitative and not closely enough connected with environment; that all the science work was controlled too much by the idea of fitting for college. A new course, a combination of biological and physical sciences was organized so as to appeal to the pupil. This new course, which was carried out by Mr. Russell and Mr. Kelly, drew

its material as far as possible from local environment and from those things connected with the interest and experience of the child; it made most of the experiments quantitative; it aimed to give minimum of principles or laws and a maximum of applications, to give the child power to interpret his physical environment; it purposed to develop interest in natural forces and to show their use in the service of man. The difficulty lay in getting teachers who were acquainted with the larger field of natural science. The success of such a course depends, of course, upon the teacher. Dr. Balliet said recently, "It was found necessary, even in this general course, to have considerable regard to the variety of abilities in the case of individual children. The aim was to find out what the child was interested in and what he knew of the outdoor world, and then the scientific work required of him was closely connected with his own individual knowledge and interest."

In Schools of To-Morrow Professor Dewey writes, "Probably the greatest and commonest mistake that we all make is to forget that learning is a necessary incident of dealing with real situations. We even go so far as to assume that the mind is naturally averse to learning—which is like assuming that the digestive organs are averse to food and have either to be coaxed or bullied into having anything to do with it. Existing methods of instruction give plenty of evidence in support of a belief that minds are opposed to learning—to their own exercise. We fail to see that such aversion is in reality a condemnation of our methods; a sign that we are presenting material for which the mind in its existing state of growth has no need, or else presenting it in such ways as to cover up the real need." During the past decade significant attempts have been made to overcome this seeming aversion to learning. One of the more recent results has been the introduction of the project method in science.[8]

[8] See: Teachers College Record for January and May, 1916. See: "General Science is Project Science", School Science and Mathematics, December, 1915.

General Science in the Normal School

William Gould Vinal, The Rhode Island Normal.

While general science is crystallizing into a definite form the normal school must anticipate as far as possible the requirements for effective work in teaching the subject. The problem of training these teachers demands organization. Is not the time ripe for an exchange of ideas? The writer feels that he has far from solved the problem but he ventures a presentation of some of the general science ideas which are formulating in his mind. It is recognized that no two normal schools should have the same course but it is hoped that the Quarterly will be a medium for the exchange of ideas. This might lead to a meeting for the discussion of the principles involved and for the purpose of fitting our ideas into a consistent, practical course.

The course in general science in the Rhode Island Normal School is given to first year pupils who have had both physics and chemistry in the high school, which means over 80% of the enrollment. The course consists of two fifty minute periods and one double period for twenty weeks. The double period is for the purpose of laboratory work, supervision in methods of study, library research, and outside trips.

General Science in Daily Life. The fundamental value of general science is proportional to the realization of the pupil that it relates to the tasks of daily life. The supreme value is in the application of scientific methods and experience wherever the occasion occurs. This gives a pleasurable quality to what is oft times mere drudgery, and thereby leads to higher thoughts and ideals. Every teacher should be trained to examine the field of science in the homes of his pupils in order to appreciate its relation to life and secondly as a basis for organization of the course of study.

The normal school girls were asked to make a list of things that they did in one day that were related to science. Nearly every one poured hot water and potash down the sink to clean out the traps. The class had been studying the plumbing of the household. The only scientific thing that one girl did was to wash the dishes and make candy. Another washed her face and hands with soap, brushed her teeth with tooth powder, washed the dishes, lit

the gas stove, baked a cake, cleaned the silver, rang the doorbell, rode in an electric car, etc. No one else mentioned washing her face and hands. Science teachers, themselves, have not agreed as to the scope of science. Is cleanliness and the action of alkali soap on the oil of the skin good science? This lesson formed a good basis for discussion and to some extent for clarifying the conception of science, if not technically, at least for all practical purposes in general science.

The Scientific Method. The scientific method is a difficult one to analyze. It is an attitude of mind. The starting point is facts. Facts are collected by means of all the senses, first hand. From several observations one may draw a conclusion. This conclusion should be tested. This stimulates further observation. The success of this method of thought comes when the pupil applies these steps, unconsciously, outside of the school room.

The teacher should not create exercises for the purpose of giving the student this line of logic but when the opportunity for the cultivation is offered this method should be used.

To train teachers not only to recognize but to acquire the scientific method is a difficult problem. The normal school students meet this experience through experiments. They are required to teach experiments before the class. Four steps are recognized: method, observation, conclusion, application. The experiment is usually demonstrated by the student teacher and the four steps are recognized and explained by the class. Different types of assignments led to the same aim, as—

a. The Fireless Cooker. Discover what the principle is on which the fireless cooker is based. Prepare a simple experiment to introduce the principle. Bring out other applications of the principle.

b. Atmospheric Pressure. Prepare to present a simple experiment which teaches something about atmospheric pressure. After several experiments have been taught give the class a short time to plan to teach the general laws concerning atmospheric pressure. Some facts are to be told by the teacher (as, 15 pounds to the square inch); some facts are to be told directly by the pupil (as, the atmosphere presses in all directions); and others are to be taught (as, the variation in pressure due to temperature.

The first exercise begins with the principle and the second ex-

periment ends with the general law. One is deductive and the other inductive. Both methods are good science.

Community Projects. It is highly important that the youth of a community should know what the science problems are that are supported by that community. They should know the nature of the work, the results, and their own responsibility as citizens. The difference between intelligence and ignorance as to the support of these issues is comparable to the difference between the seeds of anarchy and of good government. This need may be recognized in many directions, as—the Board of Health, Housewives' League, District Nursing, Sanitary Milk, Public Market, Arbor Day, City Museum, Board of Recreation, Municipal Baths, Metropolitan Park System, Good Roads, City Play Grounds, Good Harbors, Clean-up Campaigns, Fire Department, Sewerage Disposal, Water Supply, Chamber of Commerce, etc.

The pupils were asked to select one of these projects for individual study, the results of which were to be presented to the class. They were asked to make a bibliography of the literature in newspapers and magazines which was related to the home question, to visit these places whenever possible, to obtain any literature issued by the department, and if feasible to plan a little exhibit to make clear the report. The class found great pleasure in the pursuit of this data. The reports and class discussions were eminently worth while. Above all was the importance of opening a doorway to the teacher of the possibilities and responsibility of teaching children the "hygiene-preparedness" of a great city and its sociological factors. Thinking in terms of city or state is particularly wholesome in times of warfare.

Individual Projects. Much has been written of late concerning the project method. The teacher's part may be summed up in three words,—material, stimuli, and guidance. Here the "Divine right of Teachers" endeth and the "Divine right of the pupil" beginneth. Treat the pupil as a man or woman, and remember the old adage that "Every child's got to do its own growing". The teacher who is accustomed to the Cook's Tour method of treating a subject will be uneasy at this stage. To keep thirty individuals of a class absorbed in thirty profitable undertakings and to guide them into the higher forms of their own natural activities is a high ideal. I must confess that I have not attained that develop-

ment and hence have been unable to make it practicable for others. Success has been reached in some individual cases, however, and a summary is given of a few of them.

1. The senior class had been on several bird trips in the spring. Imitations of the bird calls had been practiced. One of the class reported that Miss —— was whistling bird calls to groups of girls in the cloak room. She was called to the office. Decided to take this as a special topic. Excused from the regular assignments. She gave a talk on birds, and imitated their calls, on the programme for Arbor Day. She was asked to speak to the Camp Fire Girls in a neighboring city. In order to perfect her talk she went to the Park Museum and to the teacher of oral reading. The whistling led to a deeper interest in music. She purchased a camera and took pictures of birds. This led to a desire to make lantern slides for her talk. She attended all bird lectures in the city. All this took place in eight weeks. The results were manifold as compared with the possibilities from sixteen lessons in nature-study.

2. A normal school girl just starting in practice-teaching in a training school in an insanitary district.. Nature-study became centered on the house-fly. Neighborhood began to clean-up. She went into city training. Formed a fly club. The children obtained the Board of Health Bulletins and made fly traps. Student teacher went to Washington in the summer vacation and while there visited the Department of Agriculture, the Division of Entomology, and the Smithsonian Institute. An exhibit was prepared for the State Teachers' Institute. She contributed valuable material to the exhibit and was asked to give a lesson on the fly before the Institute. She was soon elected to an important position. She has written an article on the work which is to appear in a well known school publication this spring.

3. A girl was excused from regular routine work to organize a Camp Fire group. She trained herself to become efficient in the field. Had the girls give an entertainment to get costumes. Picked poison sumach, in its autumn colors, to decorate the hall. She, and several girls were poisoned. Had been taught in class how to recognize this plant. Now has a better reason for remembering its characteristics. Gave a pageant to obtain money for summer outing. Girls went to camp for a month. Learned out-door cooking, swimming, etc. Gave an entertainment which included folk dancing and singing and had a float in old home week parade.

This chosen work has been equivalent to a course several years long in the class room.

4. Took charge of the Audubon Exhibit at the Food Fair. Asked to tell experiences before the Audubon Society. Became interested in this line. Volunteered, and given charge of the Lowell Astronomical Exhibit at the Roger Williams Park Museum. Has a position in a girls' camp for the summer. Has decided to attend the state college.

Bibliography. One method of solving questions that arise day by day is by referring to a book. It may be a medical book, a cook book, a garden book, the Old Farmers' Almanac, etc. The more momentous the problem the greater the pre-requisite for reading. Until general science becomes better organized and the text a reference hand-book, the teacher must search out her material in magazines, reports, the proceedings of learned societies, and specialized books of all kinds. This necessitates training in this line. Certain phases of general science readily lends itself to this sort of work. The topics should be numerous to insure individual work. They should not be given merely for the purpose of making a bibliography.

The following assignment proved rather valuable in this line: A list of soils, minerals, metals, and rocks, was written on the board. The pupils were asked to sign their name opposite one which interested them. Only one pupil could work upon any one topic. They were told that this was to be a test in efficiency of obtaining and organizing material. The following method of organization was explained to them as a type.

SAND.

Uses	*Adaptations*
Sandpaper	hard, rough, fine.
Filtering	clean, not easily dissolved, fine.
Hour Glass	uniform size, fine, clean, durable.
Icy sidewalks	rough, fine, hard, cheap.

The class were then given one period to work upon their selected topic. The references read were listed as a bibliography at the beginning of the paper and as fast as uses were discovered they were added to the table. An incomplete fact from one article might be found in another source and other writings were useless

for the particular occasion. It was valuable training in finding sources, rejecting unsuitable articles, in sorting out facts and arranging them. The papers were passed in and graded comparatively according to the number of points and references made. In this way one pupil might compare her own standing with the average and also the highest of the class.

The study of the bibliographies of scientists is also a good opportunity for this sort of work. This is better for outside research however, as it gives a pupil opportunity to visit other libraries and to study the topic at length. The variations of the class in stick-to-it-iveness could be plotted at this time, and some of those who were below the average in the last lesson might experience the stimulus of excelling in this line.

Biography. The study of great authors and famous generals has become a matter of course in school lessons. In science little attention has been given to this aspect. Although not essentially a part of the subject-matter, I feel sure that the biography of scientists is interesting and profitable. A list of the great contributors to scientific knowledge and their special achievement was written on the board, such as,—Harvey, Circulation of the Blood, 1616; Galileo, telescope, 1609; Schleiden, Cell Theory, 1838. The pupils were told to select one by writing their name opposite that of the scientist. The class were told that these men used the project method. They had a vision of something to be done and set about to do it. The method of study was: (1) Read the biography; (2) Pick out the steps and influences which led to the invention or discovery; (3) How can this study help us in teaching?

The class reports proved most interesting. They learned for instance, that Edison was a poor boy who earned money selling newspapers on a train. He overheard his teacher speak of him as a dunce and this spurred him on to "do things." One day when some of his experiments were upset on the train the conductor "boxed Edison's ears" which made him deaf for life. These reports gradually led the class to appreciate the hardships and many discouragements under which men who do things worth while have worked. They were usually without money and often poor in health. These student-teachers saw rather forcefully that the project method may bring something very much worth while for the backward boy or girl and also realized the great responsibility of a

teacher when she might suppress an Edison or when she might lead him on as would the great teacher in science, Louis Agassiz.

Magazines. The reading of science articles in magazines is supplementary and not anticipatory to the science lesson. The class room gives the proper foundation or stimulus. A thunder shower may occasion a discussion in regard to lightning. The many superstitions would probably lead to the desirability of reading. The teacher might refer to the article on lightning in the General Science Quarterly for November, 1916. Other articles in the same magazine might be prepared for class discussion, as,—Why Science in the Grades? Sharp debates follow the report of the article. This develops personal power. Help the class to decide whether the writing is acceptable. How is it related to previous class work? What can be done to test it out? What new information is necessary? The most up-to-date text in general science that a normal school class can have is the General Science Quarterly. It gives them points of contact with present day teaching in science. They begin to realize that general science is essentially different from book-work courses. They feel free to disagree and to test. Such a study does much to broaden the horizon of teachers of general science.

An Illuminating Gas Project

By J. RICHARD LUNT, English High School, Boston.

During the past four years an Illuminating Gas Project has been included in the General Science Course at the Boston English High School. The following problems have been selected:

1. How Illuminating Gas is Made.
2. Composition of Illuminating Gas.
3. Properties of Illuminating Gas.
4. How Illuminating Gas Burns.
5. The Gas Meter and How to Read it.
6. The Gas Range.
7. Gas Lighting: Open Burners: Mantle Burners.

The whole project requires about thirty periods of forty minutes each. The work is entirely experimental. Practically no information is supplied. Conclusions are derived through questions based on experience. The general plan may be illustrated by the

problem, "Mantle Burners." For the first lesson the Junior Welsbach is selected as one of the simplest types of upright burners.

I. *Home Study.* Examine any upright mantle gas burner. Note the different parts. How do you adjust it? Why does this mantle give light? Effect of too much gas? Too much air? Do you find any black soot? What is it? Where does it come from? How can you prevent it? Does this burner make a roaring noise? What is the cause of this?

II. *School Study.* 1. Take apart a Junior Welsbach Gas Burner. Examine and describe the nipple, cap, burner shaft and mantle.

2. Screw the nipple to a gas fixture. Open the gas cock. Ignite the gas. How does it burn? Why are there two flames? How do you explain the color of the flames?

3. Screw the cap on to the nipple. Ignite the gas. How does it burn now? Why is there only one yellow flame? Turn the cap up. What happens? Turn the cap down. What happens? How do you account for this? What part does this cap play in the Junior Welsbach Burner?

4. Screw on the burner shaft. Ignite the gas. What color is the flame now? Why has it changed from yellow to blue? What is the shape of the flame? Why is it conical? Hold a smoking joss stick near the air ports. What happens? What does this prove? Show all the places where air is supplied to this flame. Hold a porcelain dish in the flame for about a minute. Hold the porcelain dish in the yellow flame. What happens? How do you explain this? Turn down the cap. What happens? What causes this back firing? Where is the gas burning now? What is the use of the wire screen? What do you infer in regard to the relative amount of air and illuminating gas needed for complete combustion? Prove your statement. Does the blue flame give as much light as the yellow flame? Why then, is it used in mantle burners?

5. Put the mantle on the burner shaft. Hold a burning match near it. What happens? What is this? Why is it used? Turn on the gas. Hold a burning match just above the mantle. What happens? Why does the mantle give such a bright light? Would a mantle made of iron wire give light? How is this mantle made? Why is it so fragile? Why does it glow brighter than iron?

6. Put on the globe. How does the light from the bare mantle

effect the eyes? How do you account for this? Is the brightest light always the best? Try to read a book facing this light. Now turn back to the light. Which is the better position? Why is the globe used? Does all the light come through the globe? How does it affect the eyes to look at the light now? What kind of a shade would you use to throw the light down? To throw it up? To give a general illumination?

7. Try to adjust the gas so that the mantle gives its best light with the smallest gas consumption. Turn down the cap until the light grows dim. Now turn up the cap until the best light is obtained. Turn the cap up higher. Does the mantle give any more light? Why not?

8. Attach the Junior Welsbach Burner to a Minute Observation Sweephand Meter.

RESULTS FROM ACTUAL TEST.

GAS BLOWING	ADJUSTED
Consumption per hour = 4 cu. ft.	**Consumption per hour = 2 cu. ft.**
Cost per hour = \$0.0032.	**Cost per hour = \$0.0016.**
Time for 1 cent = 3 hrs. 7 min.	**Time for 1 cent = 6 hrs. 14 min.**
Cost for 1000 hours = \$3.20.	**Cost for 1000 hours = \$1.60.**

The following statistics may be of some interest. These represent the testimonials of 648 boys:

Total number of boys reporting	648
Number using Illuminating Gas	542
Number using Electricity	61
Number using Kerosene Lamps	45
Number using all Open Burners	287
Number using Open and Mantle Burners	182
Number using all Mantle Burners	73
Number using Gas Ranges	316
Number using Gas Hot Plates	94

Changes reported one month later:

Mantle Burners substituted for Open Burners	712
Adjustments of Mantle Burners	321
Adjustments of Gas Ranges	85
Reductions in Gas Bills from 5% to 60%	336
Total reduction reported for one month	\$128.00

Introductory Fire Lesson

By R. H. Williams, Horace Mann School for Boys, New York.

To give a word picture of an actual science recitation is a difficult undertaking. Even a stenographic report of such has, as a rule, the appearance of unreality. This must necessarily be, for many of the factors by which we judge a lesson are evident only under actual recitation conditions. The play of personality, the general class interest, the use of experiment and its execution and reaction on the class, are vital features of a recitation; but these do not find expression on the printed page. It is, however, a fact that many teachers desire suggestions as to a more pointed and direct method than appears on the pages of a text book. A science text, however meritorious, can give little more than subject matter. Of course, to get the real essence of a method for presenting a topic one must observe that method in action. But, however subtle a thing method may be, it probably cannot entirely escape description.

In what follows, an attempt is made to show how the first lesson on "Fire" is actually presented to a class. Not all the details of every line of discussion is given. The aim is, however, to give as concrete an illustration as possible within a limited space, of "how" as well as "what" is presented in an initial lesson on this important topic. The lesson begins with (1) a rather general discussion of the topic. This leads to the consideration of (2) a particular question or problem.

(1) Informal discussion on the uses of fire:

The discussion is usually opened by a question as,—"How would you like to live in a world where there were no fires?" or "What inconveniences would you experience if there were no such thing as fire?"

The justification of this form of question is that it has proved more thought provoking than the usual request for the enumeration of the uses of fire; it is a sharper challenge to the pupil's intellect; it is a little more novel to the child and therefore, perhaps more worth while to him. The great stock question demands of the pupil an enumeration, a telling or reciting of something rather than the giving of an opinion resulting from a mental analysis, how-

ever simple. This is not an argument for doing away entirely with the "memory question." We can never entirely abolish it so long as our present organization exists, and boys and girls are as they are. But a generous sprinkling of another kind of question is a desirable class stimulant.

The purpose of the eight to ten minutes introductory discussion is to give the class a renewed sense of the importance of fire and to lend dignity to our topic.

(2). Consideration of a question (problem), (project).

Teacher. "Important as fire is, and familiar as many of you are with it, I doubt if you could tell me just how to build one and why you build it as you do. In order that we may consider this matter very carefully, I'll put the question on the board.

How do you build a bon-fire?

Let us assume that we have here in front of the class a boy who is about your age; who has attended schools such as you have; who has lived and played as you have; who has had all your experiences with the exception of an acquaintance with fire. Of fire, he knows nothing. Now give him directions how to answer this question on the board."

Pupil. First you must get (1) matches; (2) paper, shavings; (3) coarse wood, and they must all be dry."

Teacher. "Are these arranged in the order of their importance? Suppose you were told that you could have one of these, and that you must supply the other two. Which one would you ask for and why?"

Usually an interesting discussion develops about relative values, and in life there are many situations in which judgments as to values must be made. No argument is needed, therefore, to justify an opportunity to think about values, to form judgments concerning them, and to point out differences in the values of things seemingly equal. A class of city children, in answering this question, brings out the difficulty of procuring coarse fuel, the ease with which fine fuel (shavings) may be made, and the fact that matches may be dispensed with.

Teacher. "Having, now, these three things, has this strange boy sufficient information to proceed?"

Pupil. He must learn how to place the materials. (1) He must make a little pile of the shavings and then put a little coarse fuel on top. (2) If there is a breeze, he should place the shavings on the

wind-ward side. (3) Then, he must strike the match and apply it to the shavings."

Teacher. "In case there were no breeze, or, if a very strong wind were blowing, he might experience difficulties. What would you suggest?"

Pupil. "He should fan the fire in the first case and shield it in the other."

Teacher. "This is a very inquisitive boy. He wants to learn, and you can imagine how very mysterious all this is to him. Now, look over the directions for building a bon-fire as we have it on the board, and tell me what questions this boy would naturally raise?"

Pupil. (1) "Why do you need dry fuel?"

Teacher. "Explain it to the young man."

Pupil. "Because wet fuel won't burn."

Teacher. "But the boy asks why it won't burn? The wet shaving doesn't know it's wet, neither does the match flame as you apply it. Then why doesn't it burn?"

Pupil. "——? ——?"

Teacher. "This you cannot answer just yet. But we'll answer it and other questions which this boy would ask just as soon as we have a complete list. These questions I'll place on the board. What are they?"

Pupil. (2) "Why do we need fine as well as coarse materials?"

(3) Why do you use wood and shavings for fuel rather than sand, sod and stones?" Why don't these things burn?"

(4) Why do you put the fine fuel under the coarse; and why on the windward side if there is a breeze?

(5) How does striking a match light it?

(6) How does fanning a fire aid it if there is no breeze?

(7) How is it that a strong breeze puts out a small fire?

(8) Why must you use a match or live coals to start a fire? Why doesn't it start without them?"

If the pupils have had no previous training in science, satisfactory answers for these questions will not be forthcoming. Just why a particular and familiar process gives the desired result, is not clear to them. Needless to say, this list of questions which a class will raise is not complete. It does embody, however, the main ideas which, if made clear, will give the pupil an insight into the rationale of fire extinguishers, the different methods of attacking fire, fire prevention measures, and the like. Having the

list, the teacher arbitrarily picks out one question which is fundamental and proceeds to its consideration.

Teacher. "We'll discuss first question No. 6. 'How is it that fanning a fire aids it?' I am ready to consider any suggestion you may make in answer to it."

Pupil. "Fanning a fire gives it more air."

Teacher. "I would accept your suggestion as a reasonable one if I were sure that a fire needs air. But does it?"

Pupil. "I have put out a small fire by placing something (tin pan, sand, etc.) over it so it couldn't get air, so I think air must be needed."

Teacher. "But there was some air at least in the tin pan or whatever you put over the fire."

Pupil. "But there was not enough. Fire needs fresh air all the time."

A simple experiment with candle and drinking glass is made, if the pupils need this experience before they will accept as the most probable answer to the question the suggestion offered.

This is the general plan of every attack made upon a question, problem, project or perplexity of this type. It consists of a definite statement of the question, a suggestion or guess as to the answer, and a consideration of this suggestion.[1] If it agrees with and supports previously accepted facts, the suggestion is accepted; if not it is rejected.

Teacher. "Criticize our original list of essentials for a fire."

Pupil. "Air must be added. Things necessary for a fire are (1) fuel; (2) matches; (3) air."

Teacher. "Question No. 5. How does striking a match light it?"

Pupil. "Friction lights the match."

Almost every child has this question in his earlier years, and if his memory serves him, his answer is "friction",—a term which has no very definite meaning for him.

Teacher. "Friction is the act of rubbing one body over another,— then your answer is "the act of rubbing lights it." But if I rub it between my fingers or draw it (slowly) across this surface, it doesn't light."

Pupil. "But you don't rub it fast enough."

Teacher. "Then it isn't the mere act of rubbing that lights it?"

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[1] Dewey's How We Think, Chapter VI.

Pupil. "No, you can light it without any rubbing. Touch a flame or hot stove with it."

Teacher. "But fast rubbing does something for the match which slow rubbing will not do. What is it?"

Pupil. "Fast rubbing makes heat. If you slide down a rope, or draw your finger across a table top, heat is made and you can feel it."

Teacher. "Then, what is your final answer to the question on the board?"

Pupil. "Striking a match makes heat, which lights it."

Teacher. "How is it that a piece of wood does not light when you strike it as you do a match?"

Pupil. "There is something in the head of a match which makes it light."

Teacher. "If the tip makes it light, why doesn't this match, which has a good tip, light?"

Pupil. "Because you havn't struck or heated it in any way."

Teacher. "Then what is the immediate cause of the lighting?"

Pupil. "Striking or heating it,—not the fact that it has a tip."

Teacher. "Again, why doesn't the wood light when I strike it? Do I not heat it? Even if I touch this hot plate with it, it doesn't light."

(Suggestion from experiment). Place on an asbestos board a small piece of phosphorus, lump of sulphur, and bundle of wooden tapers. Warm a glass rod and touch in turn the tapers, sulphur, and phosphorus. The rod, just warm to the hand, lights only the phosphorus. By increasing the temperature of the rod, the sulphur may be kindled, and finally the tapers.

Teacher. "If you were told to manufacture a match, what would you ask for and why?

Pupil. "Phosphorus, because it lights so easily. It takes but little heat to light it."

Before leaving the discussion of this experiment, an attempt is made to give the pupil the fact that each substance has a definite temperature to which it must be heated before it will kindle. This kindling temperature, while fixed for each substance, varies greatly for different substances. The answer to the original question,—"Why doesn't wood light when you strike it?" is then elicited.

Teacher. "The essentials for a fire as given so far are: (1)

fuel, (2) matches, (3) air. I want to change (2) so that it expresses exactly what we mean. We all know we can build a fire without a match."

Pupil. "We must have heat."

Teacher. "But how much heat?"

Pupil. "Enough to raise the substance to be set on fire to its kindling temperature."

Teacher. "Then the essentials for a fire are: (1) fuel, (2) sufficient heat to raise the fuel to its kindling temperature, (3) air. These are the supports upon which every fire rests. In this respect, a fire is quite like a three-legged stool. If one leg of such a stool is removed, we know what happens; and it doesn't matter which leg it is, the result is the same. If one of the three essentials for a fire is missing, the fire won't "stand up." Whatever you do to a fire, stop or start it, increase or check it, you do by affecting directly one of these essentials.

Now we are ready to consider the statement of a well known fact and to offer an explanation,—wet shavings do not burn, or do not burn so well as dry ones. Keeping in mind the essentials for a fire, locate the difficulty."

Pupil. "It can't be lack of fuel, for the shavings are there, although wet. Air also is present in and about the wet fuel. It must be because wet fuel can't be raised to its kindling temperature as readily as dry fuel." [Answer now the first question.]

Teacher. "If you wanted to dry damp shavings quickly, what would you do?"

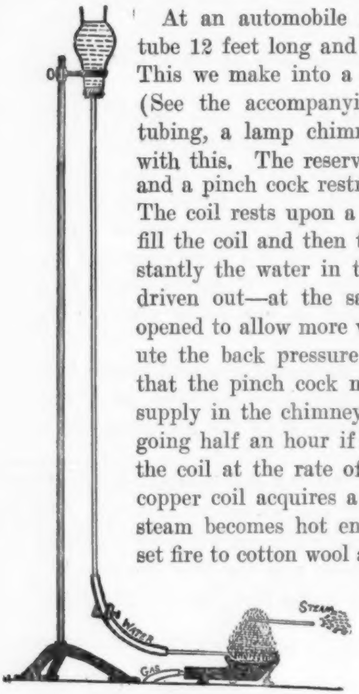
Pupil. "Put them in an oven,—heat them."

Teacher. "It takes heat then, to dry wet shavings. If I wet this taper and then hold it in the flame of a bunsen burner, you observe that it dries first. All the heat it gets from the flame is used for this purpose only. Once it is dry, however, the heat is able to raise the taper to its kindling point, and it burns."

Now you have enough science to answer at once questions (2) and (4).

An Experiment with Superheated Steam

By John F. Woodhull, Teachers College, Columbia University.



At an automobile supply house we procure a copper tube 12 feet long and one quarter of an inch in diameter. This we make into a coil by winding it around a bottle. (See the accompanying figure). By glass and rubber tubing, a lamp chimney reservoir of water is connected with this. The reservoir is raised 4½ feet above the coil and a pinch cock restrains the flow of water until needed. The coil rests upon a gas stove. The water is allowed to fill the coil and then the gas stove is lighted. Almost instantly the water in the coil is converted into steam and driven out—at the same time the pinch cock is slowly opened to allow more water to flow. After about one minute the back pressure of the steam restrains the flow so that the pinch cock may be wholly removed. The water supply in the chimney will suffice to keep the experiment going half an hour if desired. The water passes through the coil at the rate of about two drops per second. The copper coil acquires a red heat in a few minutes and the steam becomes hot enough to char paper, light matches, set fire to cotton wool and light a cigar.

"A man may have a good deal of cultivation, a good deal of information, correct information at that, about things, but if he has never made a first hand acquaintance at some point with scientific ways of dealing with a subject matter, he has no sure way of telling the difference between all wool knowledge and shoddy goods."

—*Dewey*.

The Present Status of General Science in High Schools in Pennsylvania

By JOHN H. RUSTERHOLTZ, Chicago, Ill.

As a part of my work in Science in Education, I have endeavored to determine the present status of general science courses offered by the high schools of the first grade in the State of Pennsylvania. This work is a part of a series of co-operative studies which are being conducted by the present or former students working with Dr. Otis W. Caldwell. The following questionnaire was sent to all principals of high schools of the first grade, as classified by the State Department of Public Instruction for the school year ending July 1st, 1915:

"Dear Sir:—

In connection with investigation in "Problems in Science Teaching", now being carried on by students in the Department of Natural Science, University of Chicago, I wish to obtain information regarding the work in general science in the public high schools of Pennsylvania. This investigation is a continuation of similar work done in Iowa, California, and Massachusetts, a report of which was published in "School and Society", July 29, 1916.

I should like very much to have your opinion regarding general science, even though you do not offer the course in your high school. I realize that it requires valuable time for you to give me this information, but the questions involved are of such importance that it will be helpful indeed, if you will supply the needed data."

"Is general science taught in your high school? When was it introduced? What subjects, if any, were displaced by it? What text book is used? Is laboratory work given? Is field work given? Time, in weeks?——Hours per week?—— Year when course is given? 1st, 2nd, 3rd, 4th. Are pupils from other years allowed to enter the class? What other subjects are taught by the general science teacher? What has been the preparation of the teacher in the field of science? What other science courses are offered in your high school? 1st year——— 2nd year——— 3rd year——— 4th year———.

Please give briefly your own opinion of the value of a general science course."

The writer takes this opportunity to express his appreciation of the co-operation on the part of the principals reporting. Without such co-operation the data available would not have been complete nor so reliable. If this report serves in any way to increase interest in and definite knowledge about the science work of the freshman year of the high school or in the science of the junior high school, it will have accomplished its purpose.

For convenience in comparison, the schools of different sizes have been divided into the groups A, B, C, and D, according to enrollment. Group A includes all schools having an enrollment of 500 or more. Group B represents schools of 200 to 500 pupils. Group C represents schools having 100 to 200 pupils. Group D less than 100 pupils.

A total of 298 letters was sent to principals, as may be seen in Table I, as follows:

TABLE I

	A	*B*	*C*	*D*	*Total*
Principals to whom letters were sent	39	57	112	90	298
Principals reporting	36	49	88	50	223
Schools offering general science	25	22	49	20	116
Cases where subjects were displaced by general science	11	15	36	15	77
Cases where physical geography was displaced	8	12	34	13	67
Number of schools offering laboratory work	9	19	37	19	84
Number of schools offering field work	12	16	24	8	60
Schools offering full year courses in gen. sci.	24	17	39	16	96
Schools offering 16 to 24 weeks to gen. sci.	1	5	10	4	20
Cases where general science is given in 1st. yr.	25	22	47	20	114
Schools having college graduates teaching general science	21	22	40	18	101
Schools having teachers who teach general science only	8	1	3	0	12
Schools having teachers who teach general science and other sciences	15	17	36	16	84
Schools having teachers who teach general science and subjects other than science	2	4	10	4	20

Of these 298 principals, 223 reported the position of science teaching in the schools with which they are connected. General science is offered in 116 cases, leaving 107 schools which offer no general science courses.

It is interesting to note the relation between the number of cases where subjects have been displaced by general science, and

the number of cases where physical geography is the subject displaced. This may mean that physical geography has not been dropped from the curriculum as a separate subject, but has been incorporated in the course of general science.

The total number of cases (84) where laboratory work is given includes both laboratory demonstration by the teacher and individual work done by the pupil. In many cases where little or no laboratory work is given, principals reported that such work would be given as soon as equipment and space could be provided for it, and similar statements were made regarding field work.

Of the 116 schools offering general science, 96 offer a full year course, while the remaining 20 schools devote from 16 to 24 weeks to the subject. There is some variation in the amount of time per week devoted to the subject, but in the majority of cases 3 or 5 hours per week is given.

The 114 schools offering general science in the first year include a few cases where it is given in the junior high school. This may, or may not, mean the first year of the junior high school, the data not being clear on this point.

College graduates are teaching general science in 101 schools, and of these teachers many have specialized in science and have done graduate work. Of the schools considered, 12 have teachers who teach general science only, 84 have teachers who teach general science and other sciences, and 20 have teachers who teach general science and subjects other than science.

It is encouraging to note the number of principals favoring general science, even where the subject has not been offered. The distribution of the number of principals favoring, opposing, or expressing no opinion, may be noticed as follows:

TABLE II

SUMMARY OR OPINIONS BY ALL WHO FAVOR GENERAL SCIENCE

A step in the right direction (1). A good thing (3). Expect it to be valuable (1). Stimulates more intensive study (1). A good movement (2). A very good idea (2). Splendid (1). Lays a good foundation in scientific method (11). Prepares for later science (18). Introduces pupils to a knowledge of what is meant by science (3). Has value when taught by teachers who are broad enough to recognize that general science is general science and not

general physics or general chemistry (1). A most valuable course (7). An advantage in vocational work (3). Excellent (6). Keeps pupils in school (1). Very broadening (3). Most important in curriculum (3). Offers an opportunity to those who do not continue in science and fills the needs of those who leave school early (9). Well disposed to the subject (2). Keeps pupils interested (4). Great value (6). Gives a pupil a chance to find himself (1). It gives the students "fountains of living water to drink from" (1). Better understanding of pupils environment (2). *The* subject of the freshman year (1). Appeals to 15 year old boys and girls (1). More benefit than chemistry or physics (1). Most practical science course in the high school (1). I approve of it (2).

TABLE III.

PRINCIPALS OFFERING GENERAL SCIENCE BUT NOT FAVORING IT.

Do not believe in scientific medleys (1). Little or no value (2). Seems like a hodge podge (1). Too general (1). It tries to cover too many things and not one thing well enough (1).

TABLE IV.

OPPOSITION BY PRINCIPALS WHERE GENERAL SCIENCE IS NOT OFFERED.

Have not seen the theory justified (1). I do not value it where other sciences are offered (1). No value (2). Not worth while (1). No good (1). Too general (1). Hinders rather than helps other science (1). Am not favorable to it (2). Not practical for small high schools (1). Until a more favorable text is brought forth I am not in favor of it (2).

Table V will show how rapidly the high schools of Pennsylvania are adopting general science.

TABLE V.

DATE OF INTRODUCTION OF GENERAL SCIENCE.

1899	1	1912	6
1906	2	1913	6
1909	2	1914	19
1910	2	1915	30
1911	4	1916	43

Table VI is a summary of the position of the sciences where general science is offered.

TABLE VI

General Science	is offered in	116	schools.
Physics	is offered in	114	schools.
Chemistry	is offered in	103	schools.
Biology	is offered in	66	schools.
Botany	is offered in	49	schools.
Physical Geography	is offered in	41	schools.
Zoology	is offered in	29	schools.
Agriculture	is offered in	16	schools.
Domestic Science	is offered in	10	schools.
Physiology	is offered in	6	schools.
Sanitation	is offered in	5	schools.
Bacteriology	is offered in	1	school.
Geology	is offered in	5	schools.

General conclusions may be formed from the above data as follows:

1. Of a total of 298 high schools of the first grade about 75% reported.
2. Of the schools reporting 52% are offering general science courses this year.
3. Of the schools in which general science is taught over 66% have displaced other courses by general science.
4. Of the courses displaced 87% are courses in physical geography.
5. Of the schools offering general science 72% provide laboratory work, and 51.7% provide field work.
6. Full year courses are offered by 82.7%, while 17.2% offer only 16 to 24 weeks to general science.
7. The course is offered in the first year by 98.3%.
8. College trained teachers to teach general science are provided in 88% of the schools.
9. Of the 116 principals 84.5% favor general science, about 11.2% express no opinion and about 4.3% oppose general science.
10. About 65.4% of the principals of high schools in which general science is not taught pronounce it valuable, 13% oppose it, and 21.5% express no opinion.

General Science Bulletin

(*Continued from page 188*)

BY MASSACHUSETTS COMMITTEE

Why are magnets painted red?

Does lightning strike twice in the same place?

Why are not city houses more generally protected by lightning rods?

How often does lightning strike?

Why does frost strike the low lands first?

Why does water "steam" on a cold morning?

Do fish breathe?

Why is it necessary to change the water in an aquarium?

The top of a mountain is nearer to the sun than its base. Why is it colder at the top?

21. Units actually used in a high school course in general science, as shown by a pupil's notebook.

A. The weather.

Experiments.

How heat affects water and air. How a thermometer works. Does the air weigh anything?

Interpretation projects.

Aneroid barometer and how it works. The weather map. Condensation of moisture.

Construction project.

Weather observations and records for one month.

Topics.

Rain cycle. New England weather.

B. Bacteria.

Construction project.

How to plant a bacteria garden.

Interpretation projects.

A study of yeast.

Study of bacteria gardens. (*a*) From dust. (*b*) From a decayed tooth. (*c*) From a toothbrush. (*d*) From a sneeze. (*e*) From a cat's hair. (*f*) From carpet sweepings.

Topics.

Bacteria.

The fly problem. The milk problem. The tenement-house problem.

Demonstrations.

How bacteria look through a microscope.

Germicides and their action.

C. Water.

Topics.

How Boston gets its water (this topic includes construction projects). How the water comes from Chestnut Hill. How to save water. How heat and cold affect water (includes an experiment).

Interpretation projects.

How water is measured and distributed in my home. How to read a water meter. Why water is useful. How water regulates temperature. Water pressure. How to save water.

Construction project.

How water furnishes power (use of water motor). Water pressure and elevation.

Demonstrations.

How the water meter works.

Distillation.

Experiment.

What water is composed of.

D. Electricity.

Construction projects.

To make a wet cell. How to wire your house for electricity. To construct a bell system.

Interpretation projects.

A dry cell. The telegraph. The telephone. The dynamo. The electric motor. The above includes some construction projects, namely, drawings. The electric meter and how to read it including drawings. The electric bulb.

Topic.

The school-lighting problem.

Demonstration.

How electricity is measured.

Electricity *v.* illuminating gas.

E. Combustion.

Interpretation projects.

Study of fuel. Stove. Observation of a wood fire. How my kitchen is warmed. How heat travels. Our science room. The boiler room. Steam. Water pump. Steam-air pump. How cold and hot air come to the mixing fan. The mixing fan. Study of gas burners, including costs. Welsbach burners. Various gas mantles.

Construction projects.

How to make a fire burn fast. How to check a fire. My gas stove. How to read a gas meter. Cook by gas.

Experiments.

What becomes of wood if it is burned? What smoke is. How coal burns. Study of blue and yellow flame. How illuminating gas is made. Properties of illuminating gas.

Topics.

Combustion in the human body. Generalization summary of combustion.

Hot-water heating systems (includes construction projects).

How illuminating gas is made in Everett.

QUALIFICATIONS OF A TEACHER IN GENERAL SCIENCE.

The teacher should be widely versed in science, but his knowledge need not be exhaustive in any particular field or subject. A specialist in science is not necessarily a good teacher for boys and girls in their teens, as such an instructor is likely to emphasize subject-matter and not consider the pupil's needs and limitations. The teacher should be competent to gather material from actual observation and experience as well as from lectures, laboratory exercises and books.

A desirable equipment is an alert, active interest in the natural environment, coupled with the habit of keen observation.

The purpose and capacity to organize and use material gained from the environment are important requisites. A teacher who mechanically and slavishly follows routine classroom methods, and depends upon books and laboratory exercises for material, often of so theoretical and abstract a character as to isolate the pupil

from real situations and to beget a distaste, not to say contempt, for knowledge gained by direct observation, defeats the main purpose of this subject.

Many persons well versed in scientific theory and generalizations are at the same time unobservant and ignorant of facts of everyday life. The great names of science are in the main those of persons who were led to study nature through a deep interest in some problem that came within their ken through everyday experiences, as Pasteur, in his investigation of phylloxera; Davy, the inventor of the safety lamp; Bell, of the telephone; and Lister, who solved the problem of infection in surgical cases.

The teacher of general science should be sympathetic with his pupils, know their interests, understand their limitations, and also their capacities, needs, and desires.

With such understanding he should be able to direct them when help is needed, and to supervise so as not to diminish the child's interest in his own undertaking.

The teacher should be free from bondage to conventional and traditional classroom methods of question and answer, and should not overemphasize the value of formal examinations. The teacher should also understand that many results in general science cannot be measured by formulæ or by definite standards. Such independence calls for courage.

Many teachers of general science must work with small and limited equipment, and be under the necessity of devising ways and means of gaining material. An advantage of such conditions is that the teacher must perforce seek her material by observation and in general reading rather than along the narrow, intensive lines of textbook and laboratory exercises. There is danger of the teacher becoming isolated and insulated from real experience; if so, work often becomes a matter of monotonous routine and drill, and there is an increasing tendency to over-emphasize petty matters of technique.

The teacher should be alert to note questions in general vogue, as Why are clouds colored? What is the sun? How does it keep hot? Such questions may indicate the lines along which pupils in general science should be directed. They also abound in suggestions for units.

The teacher should be resourceful, widely read in current scientific literature; broadly informed in the field of nature; accustomed

to observe and to seek interpretation of phenomena; frank to admit ignorance, and to recognize that many problems are unsolved. He should, however, be able to impress the pupils with his ability to go far, if necessary, in study and research upon any particular topic. Many opportunities to show this capacity will be afforded.

Teachers should guard against the temptation to use uniform material and against methods distinctly didactic; they should encourage initiative in pupils, seek to arouse real interest, and thus give instruction in general science in accordance with the aim of this subject.

EQUIPMENT FOR GENERAL SCIENCE.

In view of the wide range of projects and experiments from which selections may be made, an elaborate equipment is not necessary, as much may be done with material found in the school building and its surroundings. A small high school, consequently, is not at as great a disadvantage in respect to material and equipment for general science as it is in the case of subjects requiring an extensive outfit of apparatus and illustrative devices.

There should be a good sized workroom, which may be used for manual training, and possibly for the formal sciences, in which the class in general science meets. Provision should be made so that each pupil may store, when necessary, material and apparatus with which he is working. Tables of a simple type, equipped with gas and water, are required.

In large city high schools a more extensive equipment is necessary, inasmuch as it is not so easy to bring the pupil into contact with nature, and with illustrations in his surroundings.

A large amount of reading material, including magazine articles, books and newspapers, should be available. Notebooks should be furnished the pupil in which to enter the results of his reading, experimentation and observation.

The teacher in general science should build up a school reference library. Use can also be made of the town or city library. Several good textbooks are desirable out of which material can be gathered bearing upon a given topic. No single textbook, however, should be used exclusively, nor should any textbook be the basis for the kind of material or the order in which topics are considered.

The teacher of general science should have ample time in which to prepare and arrange material, and to become acquainted with the local resources in objects, processes and phenomena to be studied, observed and reported.

Optional Project Work in Chemistry

By Charles H. Stone, English High School, Boston.

While in every large class the greater number of pupils will be of average ability, there will always be a few drones, and a few students of more than ordinary calibre. One of the problems of the teacher is to devise ways to stimulate the dull pupil to more active effort, and to provide opportunity for the exceptional student to carry on additional work.

The latter problem is, of course, the easier of the two. And yet, in the teaching of chemistry, the method often followed in the laboratory for providing further opportunities for the bright student does not always seem satisfactory. It is easy enough to set the youth to work at more experiments of the same character as those he has just completed, but the charm of novelty is, to a certain degree, lacking in this case, and the youth cannot be blamed if he sometimes displays a waning interest when set to work on "more of the same thing."

In the English High School, this matter has been under consideration for some time. The method of providing bright students with additional experiments of same character as those already done was rejected for reasons given above. It was not thought advisable to turn to Qualitative Analysis, since the elements of it had already been included in the regular course. Quantitative Analysis was out of the question for two reasons; first, because the apparatus at hand was inadequate, and suitable balances and equipment could not conscientiously be asked for; and second, because even a bright high school student has not yet attained the needed skill to make work of that character profitable. But with a considerable number of bright boys, out of a registration of some one hundred forty more or less, asking for something more to do, the need of "knitting work" for them was evident. Here was an opportunity to experiment in so-called "projects" without interfering with the regular class work. It was thought that such new work should have the charm of novelty, that it should be useful and informational in character and that it should also be along the line of the student's interest. Extended project was decided upon as appearing to offer the best solution of the problem.

Accordingly, two years ago, a set of experiments on the chemistry

of Textiles was prepared. These experiments, some thirty in number, were printed off on the Neostyle, and given to any of the students who had finished the laboratory experiments required for the bi-monthly period, and who were interested in undertaking additional work. Some very creditable results were obtained, and the interest shown seemed to confirm the opinion that project work along the lines indicated was worth further development. It was evident, however, that there was need of other lines of work to better satisfy the pupil's interests.

Last year, two more sets of experiments were prepared. The first of these deals with the Chemistry of Foods, and includes: testing for starch, preparation of Fehling's solution, testing for sugars in foods, digestion of starch and sugars, fats and oils in foods, Halphen's test for cotton-seed oil, test for proteins, digestion of proteins, Babcock test for butter fat in milk, total solids in milk, preparation of casein and milk sugar, testing vinegar, and some other similar experiments. These experiments had the advantage of showing some applications of chemistry to problems of daily life, they afforded opportunity to introduce burette work in testing vinegar and making the Babcock test, and proved of much interest to the boys who undertook the work. A good deal of supplementary reading was necessitated which was valuable. Visits were made to places where food work was carried on, one visit being to the State Board of Health at the State House, where a great deal of pains was taken by the chemist to show what the state is doing in the analysis of foods, water, etc. This set of experiments appealed especially to those boys who contemplated a course at the medical or dental college, as well as to a number of others. It was noted that some boys who had not shown remarkable interest in the regular work of the laboratory were more ready to take up these experiments, when they were allowed to do so.

The second set of experiments on Industrial Chemistry was intended for boys who were interested in the applications of chemistry to industries and manufactures, or who had in contemplation a course at the Agricultural College. This set includes: preparation of emulsions for spraying trees; manufacture of ammonium sulphate from the ammoniacal liquor of the gas works, and superphosphate; preparation of lime-sulphur spray, Bordeaux mixture, Paris Green, and lead arsenate; manufacture of sodium nitrite and the preparation of a dye from it; manufacture of Solvay and caustic soda; preparation of a dye and an indicator, and the produc-

tion of pigments for use in paints. A very interesting exhibit of the products of these experiments was prepared.

A rather interesting incident in connection with the above experiments came recently to the writer's attention. Last spring one young man made a dye in the laboratory. He carried the dye home to show to his parents. Unknown to him, his mother used some of the dye to color a silk waist. The dye proved very satisfactory and the waist came out nicely colored. After it was all over, the young man learned of this interesting household experiment with his dye. It is safe to say that his experiment with that dye and the subsequent unexpected but satisfying development and demonstration of the usefulness of his product meant more to him than many another experiment performed in the regular course.

Under the textile experiments, students test cotton and wool for their reactions toward chemical reagents; they wash, scour, and bleach wool, and scour and bleach cotton yarn and cloth. The wool is taken as it comes from the back of the sheep and is made ready for the spinning process; they study the effects of acid, basic, and substantive colors on wool and on cotton, work out two-color effects on mixed goods, and carbonize wool to remove vegetable fiber; they diazotize and develop new colors on cotton, analyze dress goods, dye silk, and perform other similar experiments. The set appeals to boys who are interested in dress goods or who intend to take courses at some textile school.

The psychology involved is simple. Every one works with best effort at the thing in which he is most interested. After the regular laboratory work of the bi-monthly period is finished, the particular interest of each student is consulted, and so far as possible work along that line is given him; this interest usually falls into one of the three lines already indicated. The work appeals to him because it is different and has the charm of novelty; because it seems useful since it involves the application of the chemical facts he has already mastered to the simple every day matters of food and clothes and common industries; and lastly because the particular set he is given is along the very line in which his own interest is already working. Chemistry becomes to him now more alive than ever for he sees its usefulness in its applications to industries and to life.

It may be said that work of this character is entirely optional with the boys; no one takes it under compulsion. But also, no one

takes it who has not completed the specified amount of required experiments. For those who are interested, work of this character serves as an incentive to better economy of time and closer attention to the regular exercises in order that time may be gained for the special set they wish to do. The hold that this kind of work has is shown thus; in spite of the fact that it is entirely optional, boys appear almost every morning before school to work in the laboratory and will remain after school as often as the instructor will permit. Not always the same boys, to be sure, but the fact that any boys come, and come repeatedly, shows that they care. No boy will devote extra time in that way unless he is really interested.

It may be urged that the preparation of the experiments means a large amount of work for the teacher. Of course, it does. Material must be collected and tried out first, copy must be made and rewritten; but the manual labor of duplicating stencil copies can be turned over to some student of typewriting. Once prepared, the labor attached to the experiments is no more for the teacher than it would be if the student were to go on with such other experiments as might be assigned him from the regular manual. The increased interest and enthusiasm offsets the labor of preparation.

Introduction to the Gas Engine

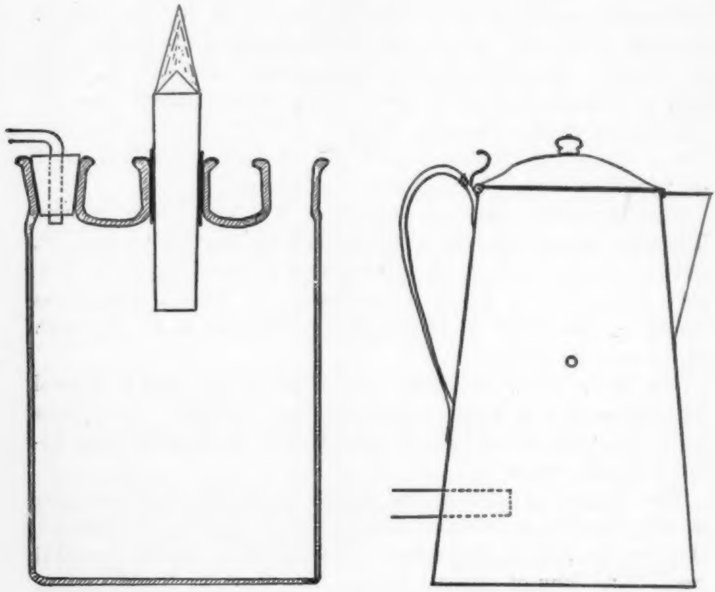
By GEORGE A. COWEN, West Roxbury High School, Boston, Mass.

The following demonstration experiments have proved very satisfactory in my classes, in holding the interest and in giving the pupil a clear understanding of the principles involved in gas mixture explosions. They are well adapted for use preliminary to gas engine study.

Fit the middle neck of a three-neck Woulff bottle with a glass tube, which extends about three inches into the bottle and four inches above the bottle. A rubber tube may be used to hold the glass tube in place. A liter bottle may be used. The right hand neck is open; the left hand neck is fitted with a stopper and glass tube for the admission of gas.

To use the bottle proceed as follows: Holding the hand over the open neck let the gas fill the bottle. When it is filled, light the gas at the top of the tube. Turn off the gas and remove the hand from the right hand opening. Air enters through this opening.

When the mixture is of the right composition a harmless explosion follows. The purpose of this part of the exercise has been to show the need of a mixture of gas and air in correct proportions to make an explosion.



The second step is designed to show the need of removing the products of explosion in order to have the action repeat itself.

To do this a coffee pot is prepared with a hole at the bottom large enough to admit a Bunsen burner. Half way up on one side a touch hole is made, so that an explosion can be caused by bringing a lighted burner to it. The first explosion occurs as soon as the mixture is in the right proportions. The cover, representing the piston of the gas engine, is thrown back by the force of the explosion. It hits a wire conveniently placed and returns to its place. The action repeats itself two or three times, but no more. When the pot, representing the cylinder of the engine is emptied of the products of combustion, an explosion will again occur.

The class is now ready to work with the real engine, a small, four cycle gas engine.

General Science Meetings

Mr. Howard C. Kelly of Springfield, Mass., gave an address on General Science, before the Hampden County Teachers' Asociation, on October 27, 1916.

General Science Club of New England held its first regular meeting on Nov. 18, 1916, in the Lecture Room of the Boston Public Library. About 75 teachers were present. Dr. Otis W. Caldwell of Chicago University gave an interesting address "An Interpretation of Our Changing Point of View." Mr. Leonard Patton, Principal of Edward Everett School, gave a practical paper on "An Experiment in Eighth Grade Science."

The Elementary Science Section of the New Jersey Science Teachers' Association held a General Science meeting on Nov. 18, 1916, in Hackensack, N. J. There were addresses by G. L. Bennett, Albert Earley, and A. C. Johnson, Jr. The discussion was opened by Miss Angie G. Albee. Miss Caroline G. Howe, chairman of the section, presided.

The Rhode Island Teachers' Science Association held a General Science meeting at Brown University, Dec. 13, 1916. An address by W. G. Whitman on "The Project Method in Practice" was followed by discussion.

The Science Division of the Oregon Teachers' Asociation gave special attention to "General Science" at its meeting in Portland, Ore., on the 28th of December. Two important papers presented were, "The Why of General Science," by Prof. L. P. Gilmore of Oregon Normal School and "The How of General Science," by Francis D. Curtis of Portland.

The Rhode Island Normal School held a General Science conference and exhibit in Providence on Jan. 13, 1917. The conference itself was a most valuable one. The exhibit was attractive and full of suggestions. There were books for texts and general use, and commercial literature of practical value. Models of stoves, derricks, engines, fireless cookers, lift pumps, fire extinguishers, etc., were shown. These are suitable for eighth and ninth grade construction projects. Community projects were represented by exhibits and demonstrations by the State Board of Health and the City Milk Inspection Department. Normal students demonstrated many applications of General Science to everyday home duties.

More than 100 Boston teachers met on Feb. 17 to discuss General Science for the Elementary and Junior High Schools of Boston. The meeting was in charge of Mr. J. Richard Lunt, of the English High School.

At the Science Section meeting of the Northeastern Minnesota Educational Association held in Duluth, Feb. 23, Mr. E. A. Stewart of Gilbert gave an address "Value and Place of General Science Course." Mr. N. J. Quickstad of Virginia, presided.

Feb. 25, at the meeting of the N. E. A. Department of Superintendence, in Kansas City, Mo., Prof. Otis W. Caldwell gave an address on "Economy and Efficiency in Science Teaching."

The second regular meeting of General Science Club of New England was held at the Boston English High School, March 10. The following men spoke upon the subjects given: Frank P. Morse, Principal Revere High School, General Science in the Junior High School. William Orr, New York, Principles of Selection and Organization of Material in General Science. A. W. Taylor, Salem High School, A Study of Weather. Geo. A. Cowen, Roxbury High School, Demonstration—Introduction to the Gas Engine. J. Richard Lunt, Boston English High School, A Project—Illuminating Gas. Howard C. Kelly, Springfield H. S. of Commerce, A Demonstration—Care of the Teeth. Chas. H. Stone, Boston English High School, Simple Experiments in Textile Dyeing. More than 100 teachers were present.

On March 29, Mr. Adrian A. Worun of Sault Ste. Marie, presented a report on "General Science in Michigan Schools" and Miss Mabel Hardy of Highland Park, presented a paper, "General Science in the Junior High School," at a meeting of the Michigan Schoolmasters' Club at Ann Arbor.

At a meeting of the Rhode Island State Science Teachers Association, held at Brown University on March 31, Mr. R. D. Tucker of the Rhode Island State Normal School gave a paper on Apparatus for General Science and Mr. R. C. Lowell, English High School, Providence, on Home Experiments in General Science.

At a meeting of the New Jersey Science Teachers' Association, at the Camden (N. J.) High School, April 14, Miss Caroline G. Howe of Newark, gave a report on the Status of General Science in New Jersey.

Book Reviews

First Course in General Science. By F. D. BARBER. Henry Holt and Company. Pp. 607.

"The Book that is different" characterizes Barber's "First Course in General Science", different from the majority of texts in General Science in at least three aspects: selection of subject matter, fewer topics are treated, but these topics are enriched with a wealth of drawings, exercises, tables, maps, illustrations, and other material.

Development of subject matter: the development is logical, thorough, and scientifically accurate. Physical laws, principles, and definitions are introduced at the point where they are necessary for a clear understanding of some of the common phenomena that the child encounters in and about the home, primarily. For example, when the author wishes to show how a chimney creates a draft, he tells the old story of Archimedes and then introduces an exercise demonstrating the law, then it is an easy step to show the analogy between a floating cork and the hot gases in the chimney.

The book is not a hodge-podge of all the physical and biological sciences. The author has avoided scrambling these sciences which later in the pupil's high school course are unscrambled.

At first glance the book may appear formidable with its 598 pages of almost solid matter, but this is a distinctive advantage in that it offers to the teacher a chance to select the chapters that might be of special interest to her students because of their environment. The book is very teachable, but in a few instances the author has carried his development beyond the comprehension of the average first year high school students, particularly his development of the efficiency of man and machines.

La Salle, Illinois. GEO. MOUNCE.

Laboratory Lessons in General Science. By HERBERT BROWNELL. The MacMillan Company. Pp. 240.

Almost without exception every author of a general science course up to this time has given the high school teachers a full year in which to become fixed in the text book method of instruction before placing a manual in their hands. Yet, they say, general science is a laboratory science. Professor Brownell's first book on this subject is "Laboratory Lessons in General Science."

Laboratory manuals have a tendency to use only the laboratory for meeting their requirements. True to the methods used by all individuals in life's laboratory, Professor Brownell, in this manual, has the pupil seek his answer in his own experiences and in books as well as in laboratory experiments. In doing this, questions call for facts the pupils have already gleaned from life. Directions help the pupil to turn to the laboratory for the assistance it can give, and specific

references enable the student to use the library readily and without an undue waste of time.

The author has made bold to take a step which no other writer of general science texts has, as yet, taken. He places the social upon the same plane with the natural sciences and stresses that phase of every topic throughout the manual.

Another characteristic, which appeals to all who regard the public schools as responsible for the moral training of pupils, is the frequent reference, in its directions, to the value of right conduct in the life of the individual student. Such a chapter as that on "General Science and Right Living" and many incidental appeals tending to lead pupils to act wisely when a moral crisis comes, are very gratifying.

The appendix contains a list of apparatus needed, a list of reference books for the library, a list of government bulletins and specific references for class assignments. Considered from many angles, it promises to be one of the successful manuals. It will, as well, be a storehouse of suggestive material for grammar grade teachers.

Peru State Normal School, Nebraska. B. Clifford Hendricks.

Elements of General Science. By Otis W. Caldwell and W. L. Eikenberry. Ginn & Co. Pp. 308.

It is very evident that the authors of this text were serious students of the general science problem. They were aware of the fact that there was a need of and a demand for a science differing in content and method from the traditional high school science. This need has been met in this book in a very rational and scientific manner. The course presented has the "ear marks" of one tested and tried. the popular cry for "something different" did not mislead the authors into giving a spineless and highly entertainingly collection of unrelated and "near science" stories. This text has a purpose,—entirely commendable from an educational standpoint,—it is to place before the pupil some of the larger and more fundamental facts, principles and notions of the science of the common yet significant things.

The book embraces five major topics: Air, Water, Work and Energy, Earth's crust and Life upon the earth. It will be observed that a feature of the book is the comprehensive and suggestive treatment of a few rather than a brief glance at many topics.

The teacher who is very dependent on his text, will experience some difficulty in stretching this book over five periods per week for a year. It is assumed, however, that general science instruction will not be entirely confined within the covers of a single book. If one wishes to get a representative cross-section view of this text, he should examine particularly chapters I, V, VI, XII, XIII and XVI. These include those topics toward which pupils react with the greatest and the least profit.

Horace Mann School for Boys, New York. Roland H. Williams.

An Introduction to Science. By BERTHA M. CLARK. American Book Company. Pp. 494.

This work is virtually the author's "General Science" enlarged and expanded into a veritable cyclopedia of elementary science. True to its name it is a *real* introduction to *very much* science. Probably no other similar text contains so much information about science and its applications.

The scope of the book is well indicated by the following: heating and ventilation, foods and diet, bread making, patent medicines, soap making, paints, fertilizers, oxidation, bleaching, magnetism and electricity, sound, light, machines, gas engines, community sanitation, a short course in physiography, and some of the best things in botany and zoology.

Accordant with the spirit of present-day education, it is upon the *practical* that emphasis is laid throughout the book.

In producing a book so comprehensive and so intimately linked with contemporary life, the author has demonstrated surprising energy in exploring the vast field of science in industry, and commendable boldness in selecting what seems reasonable without regard to tradition.

Probably few teachers—particularly in larger communities—will care to present very much subject matter to their classes in elementary science that is not found in this book, and few classes will try to cover the entire book in one year.

The text is fairly well illustrated, but a more liberal use of pictures and diagrams would have improved it, and to many teachers review questions at the end of each chapter would have made the work more serviceable.

Dickinson High School, Jersey City, N. J. M. C. LEONARD.

General Science, First Course. By LEWIS ELHUFF. D. C. Heath and Co. Pp. 433.

One of the latest comers in this broad field of general science is the above title. As stated in its preface, "this book is intended to offer a scientific explanation for the many and varied experiences which pupils of high school age have had and to create a desire for further knowledge of scientific subjects." To this end, the author endeavors by his arrangement of subject matter to secure the following results: a desire on the pupil's part to grow strong in body and mind, to remain free from disease and to avoid the use of stimulants and narcotics; a development of a logical method of thinking so that pupils may have minds open to new facts and principles, thus relieving them of some of their superstitions; a desire for more knowledge and further scientific study. The author has laid out work for more than a half year, but makes helpful suggestions for omitting to fit local conditions. A textbook in general science should furnish topics and suggestions for class discussion and give the student an orderly arrangement of reference material. After a brief introduc-

tion in which the author points out many good reasons for the study of science, there follow chapters on health, chemistry of common things, cooking, carbon dioxide, breathing and ventilation, matter and energy, and the author compares nutrients, to give some idea of diet and food supply, touching finally upon the purchasing of food. Interesting cuts are inserted at frequent intervals. There is an interesting introduction to the subject of machines, following directly the work on gases.

The work on pumps is separated by four chapters from that on the barometer, for what advantage seems not clear. Considerable space is devoted to the Pittsburgh water supply, and there is in addition an excellent treatment of other systems. At this point the halfyear course ends for many schools, according to the author. He has added chapters to be used if there is time and the teacher must exercise judgment in selecting from this store, to suit his own conditions. Some of this material might properly come into the first half year displacing much of the mechanics of solids, it would seem. These later chapters include magnetism and electricity, light, hearing, sight, an attractive account of soils, directions for care of gardens, a little elementary plant physiology, some mention of the use of plants to man, insect pests, a short discussion of animal life, and ending with a simple description of the solar system. As a whole the book is well written. The task of the teacher will be to select the material and adapt it to his own conditions. The glossary at the end is a convenience, saving trips to the dictionary. There are some excellent suggestions to teachers and each chapter is followed by a set of well worded questions. Pictures of actual plants and eminent scientists add much interest to the book. As a whole, the book is very worthy of a "place in the sun" along with the many other texts on this much discussed subject.

Central High School, Springfield, Mass. C. M. HALL.

The First Year of Science. By JOHN C. HESSLER. Benjamin Sanborn and Company. Pp. 484.

The First Year of Science is designed, in the words of the author, to "stimulate uncommon thinking about common things" in a course that shall be "fundamental to the entire field of science, and not be any one of the special sciences." Just what shall constitute such a course is a matter upon which opinions differ, as evidenced by the many varying texts published in an effort to produce a standard.

The fundamental descriptive matter in this text consists of elementary physics and chemistry, leading to matter, which in the special sciences would be classed as physiography, botany, zoology, physiology, hygiene and others. There is no abrupt division of topics under the above headings, the subjects in each chapter being presented in sequence applicable to the actual experience of the young boy or girl. There is no rigid transition from one chapter to another, however, so

that the teacher may vary the order of topics to conform to his own plan for maximum results.

Illustrations are abundant, including both diagrams and half tones. Each chapter has a summary and exercises, some of the latter being of a quantitative nature. This combination is a great help in review: the summary and some of the exercises test the anchorage of subject matter, and the particularly plentiful questions about the practical side of each topic convince the pupil that the information in this text, at least, is the kind he will want to remember because he can use it.

This text works well in class use, both as a source of readily available information and as a basis for recitations. Numbers on the topical paragraphs make the assignment of very definite lessons easy, even though one assignment may include sections from widely-separated parts of the book. The handbook for teachers has directions for carrying out simple demonstrations, answers to problems, and suggestions for rounding out much of the descriptive matter of the text itself. In the laboratory manual the great majority of the experiments call for apparatus that is usually near at hand or available at little expense. Additional diagrams here would help.

General science teachers who believe in the subject will have ideas of their own, and will do their best work putting those ideas into execution. It is still too early to look for a truly standard text that will meet the requirements of most live general science courses without modification. A text with plenty of good substantial information in science so built that it is flexible enough to give play to local ideas, and plain enough so that young boys and girls may use it effectively is the very best to be had. Hessler's First Year of Science has given very acceptable service in the classes of the writer.

New Haven High School, Conn. M. MARCUS KILEY.

First Science Book. Physics and Chemistry. By LOTHROP D. HIGGINS. Ginn & Co. Pp. 237.

General science is elementary science, but all elementary science is not general science. General science as now advocated means the science that is nearest at hand. Elementary science may lead to the comprehension of all science or it may lead to a special science. Physics and chemistry are special sciences. This book is frankly elementary physics and chemistry and not general science. Its object is to give the pupils "an introduction to scientific study" and secondly "to show the practical bearing of the various subjects upon affairs in our daily experience, such matters being introduced wherever they may serve to illustrate or explain". Many prefer to reverse this by commencing with daily life and whenever a problem needs explaining to make use of the science that is necessary at that time.

The method of the author is to begin with the simplest and progress logically to the more complex, as: elements, compounds, mixtures, common chemical processes, etc. General science begins with that

part of science which interests the pupil. It begins with lighting when it is a question in the long winter evenings; or it begins with soil when it is a matter of conserving moisture for the spring garden. The first method might be diluted from almost any text book of physics or chemistry. Both methods are scientific. Elementary science is taught for the sake of the subject; general science is taught as the subject is needed.

Although an old book (published 1905) there are teachers who prefer to have an introduction to the specific sciences and this book serves that purpose. The subject is still in an experimental stage and it is well to have teachers trying out all phases.

The book is well illustrated. At the end of each section is a list of questions which are suggestive.

Rhode Island State Normal School, Providence. W. G. VINAL.

A First Year Course in General Science. By CLARA A. PEASE. Charles E. Merrill Company. Pp. 315.

The problem of writing an elementary science book covering the field now quite generally accepted, and organizing this material in such a way that it is presented to the pupil as a series of interrelated problems, has evidently not been solved. Possibly the material of this field cannot be so organized. Our texts seem too fragmentary and the knowledge content for the present, at least, must be their principal justification.

However, other things being equal, that text which weaves its material about the fewest organizing factors has obvious advantages. From the environment of the pupil such material must be selected for such a text as will be of vital interest and at the same time be susceptible of such scientific explanation as will be within the grasp of the first year student.

First Year Science, judged by the above standard, compares very favorably with any text that has thus far come to the notice of the writer. The topics about which the material is grouped are not large and are presented in a logical way. The book, like most others on the subject, is largely an earth science text. Especially noteworthy are the first two chapters under the heading of "The Place of the Earth in the Universe." Whether or not this approach to the subject is pedagogical, when tested by the class room test, it works.

The use of scientific terminology throughout the book is commendable. It places in the child's vocabulary, and gives meaning to those scientific terms which are to be met with again and again throughout his general reading whether high school is finished or not.

The purpose of and the selection of the questions, as a whole, at the end of each chapter is most excellent. They are not only a review, but are intended primarily to test the pupils' ability to apply the knowledge gained in the chapter to concrete cases.

The style of the text is clear, concise and readable and the minimum of trouble is experienced in the pupil getting the thought. The text is not without minor errors and statements or inferences which

should not have been overlooked. Two or three illustrations will suffice. For instance, in the explanation of springs and artesian wells all layers of soil whether it be gravel, sand, clay or what not are termed rock. In the absence of any such definition of rock it is difficult to see just how the discussion will be very clear to the large number of pupils who have never seen the outcroppings of any bed rock (P. 85) The writer is not yet sure what was meant by the question "Which is more valuable, a gem cut from rock crystals or one made from Amethyst?" (P. 176) Equally confusing appear the questions 4 & 5 (P. 224) asking how we distinguish in "General" and in Particular steep slopes from a contour map.

Traverse City High School, Michigan. G. H. CURTIS.

Elementary General Science, Book I. By PERCY E. ROWELL. Published by the author. Pp. 197.

In the preface we read, "The science which is most valuable to the child is that which explains the phenomena of the environment—the science of common things—the science of everyday life. No one branch of science can do this. . . . A blending of all branches of science, as a means for the best teaching of it in the grades, is inevitable."

There is a dearth of science books for the elementary schools and many teachers will find this little book of much value in their classes. It has numerous illustrations. R. M.

Introduction to General Science with Experiments. By PERCY E. ROWELL. The Macmillan Company. Pp. 295.

This was published in 1913 and no later edition has yet appeared. No space is given to drawings or pictures. The work is certainly true to its name, it is *general.* No particular branch of science is emphasized. Chemistry, Physics, Geography and Botany are interwoven. The plan of the book is splendid. A paragraph or two is given on a subject, then a number of definite references are cited where the pupil may find a more extended discussion. An experiment usually follows.

In the front part of the book a good list of references is found with directions for use. The experiments are interesting and stimulating and well within the grasp of a first year high school student. They can easily be performed in a forty-five minute period and no elaborate apparatus is necessary.

I found this book of great service in my first year classes. However, I would not recommend it to an inexperienced teacher as a text, for to be of value it must be used together with the references.

Boston Trade School. THOMAS D. GINN.

First Year Science. By WILLIAM H. SNYDER. Allyn and Bacon. Pp. 470.

This text is an attempt to unify the elements of some ten special

sciences in a course which deals with the earth and the sun in their relation to man. The text really is physiography with rather more than ordinary emphasis upon related science topics. It is in simple language and is well illustrated. Has summaries and questions at the ends of chapters. There are 133 experiments in fine print included within the text. It is a little questionable to state as the author does in the preface, that "The book is complete in itself; no reference library, no manual, is needed." R. E. N.

An Introduction to the History of Science. By WALTER LIBBY. Houghton, Mifflin Company. Pp. 288. $1.50.

Here is a history of science which will fascinate high school students. The scientists and the stories of their work, here told, are so closely interwoven with the subject matter of high school science that they will serve to vitalize the entire science curriculum. The practical bearing of science from remote early times to the present is a feature of the book. The frontispiece in this number of the Quarterly is one of the plates which illustrate this book. Libby's History of Science will give student or teacher an added appreciation of science of today through the background of the science of the past. W. G. W.

Problems of Secondary Education. By DAVID SNEDDEN. Houghton, Mifflin Company. Pp. 333.

Three chapters in this book are in the form of letters written respectively to teachers of physics and chemistry, to teachers of biology and to general science teachers. Not only are the present day defects in our science teaching clearly pointed out, but many suggestions are offered for securing a new, successful and useful program of science in the high school. No progressive science teacher will fail to read these chapters and to meditate thereon. W. G. W.

LABORATORY MANUALS IN GENERAL SCIENCE.

BARBER. No laboratory manual is published, but there are 103 exercises scattered through the text in appropriate places. These are in fine print to set them off from regular text material.

BROWNELL. *Laboratory Lessons in General Science.* Reviewed above.

CALDWELL, EIKENBERRY and PIEPER. *A Laboratory Manual for Work in General Science.* 94 exercises, 134 pages. The exercises are printed on large sheets with blank space for the pupil's rcords. It is supplied either as a bound volume or as loose sheets.

CLARK. *Laboratory Manual in General Science.* 92 experiments, 96 pages. This was written to accompany Dr. Clark's first text, General Science.

CLARK. *Laboratory Manual for Introduction to Science.* 100 experiments. 203 pages. Large sheets, in loose-leaf form. Blank spaces are left beside the printed directions for the pupil's notes.

ELHUFF. *Laboratory Manual for General Science.* 112 exercises, 90 pages. The author suggests that many of these exercises be made demonstrations by students or instructor. Some exercises are recommended for home work.

HESSLER. *Laboratory Exercises for the First Year of Science.* 107 exercises. 118 pages. This is to accompany the author's text. Each exercise is prefaced by a list of apparatus and materials needed.

PEASE. Laboratory Manual. 31 exercises. 41 pages. Each exercise refers to the definite sections of the text book, to which it is related. Bound with the text or separate.

SUMMER COURSES IN GENERAL SCIENCE.

UNIVERSITY OF CALIFORNIA. *Theory and Practice of Instruction in Introductory or General Science.* The course is given by Percy E. Rowell, A-to-Z-ed School, Berkeley, Cal.

COLUMBIA UNIVERSITY, TEACHERS COLLEGE. *The Teaching of General Science in the Elementary and Junior High Schools.* Two courses for class work and a laboratory course. The courses are given by R. H. Williams and A. I. Lockhart of the Horace Mann School, New York.

COLUMBIA UNIVERSITY, TEACHERS COLLEGE. *Organization of High School Science.* In this course more attention will be given to general science than to any other one science subject. Given by Otis W. Caldwell, of Teachers College.

HYANNIS (MASS.) STATE NORMAL SCHOOL. A general science course has been given for the last four years, but is not offered this summer.

ILLINOIS STATE NORMAL UNIVERSITY. *A course in General Science for High School Teachers.* This course has been offered for the last three years under the direction of Fred D. Barber. This summer the course is given by W. L. Goble, Principal of the Elgin High School.

IOWA STATE COLLEGE. *General Science for High Schools.* Fred D. Barber will give a course similar to the one he has given in previous summers at Ill. Normal University.

KIRKSVILLE, MISSOURI, STATE NORMAL SCHOOL. A course in general science will probably be given in the summer session by W. J. Bray of the Kirksville Normal School.

UNIVERSITY OF NEBRASKA. *Teacher's Course in General Science.* Suited to high school use. Classroom and laboratory practice. The course is given by Herbert Brownell, of the University of Nebraska.

PERU, NEBRASKA, STATE NORMAL SCHOOL. *Course in General Science for High School Teachers.* Classroom and laboratory. Course given by B. C. Hendricks, of the Peru Normal School.

UNIVERSITY OF NORTH CAROLINA. *General Science.* Course is given by P. H. Daggett of the University.

UNIVERSITY OF PITTSBURGH. *General Science in the Junior High School.* Course I. G. S. in Seventh and Eighth Grades. Course II. G. S. in Ninth Grade or First Year of High School. The courses are given by W. G. Whitman of the State Normal School, Salem, Mass.